

U. S. DEPARTMENT OF AGRICULTURE.

ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR

THE YEAR ENDED JUNE 30, 1903.



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To the Senate and House of Representatives:

I transmit herewith the annual report of the Office of Experiment Stations, prepared under the direction of the Secretary of Agriculture, which includes a report on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1903, in accordance with the act making appropriations for the Department of Agriculture for the said fiscal year.

The attention of the Congress is called to the request of the Secretary of Agriculture that 5,000 copies of the report be printed for the use of the Department of Agriculture, and that provision be made to print such a report annually.

THEODORE ROOSEVELT.

WHITE HOUSE, *February 5, 1904.*

LETTER OF TRANSMITTAL

U. S. DEPARTMENT OF AGRICULTURE,

OFFICE OF THE SECRETARY,

Washington, D. C., February 4, 1904.

SIR: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, prepared in accordance with my instructions. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, for the fiscal year ended June 30, 1903, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress.

Reports are also included on the experiment stations in Alaska, Hawaii, and Porto Rico, which are provided for in the appropriation act aforesaid and are directly managed by this Department.

If this report is published by Congress, it is desirable that 5,000 copies should be provided for the use of this Department, and that provision be made to print such a report annually.

I have the honor to be, sir, your obedient servant,

JAMES WILSON,

Secretary.

The PRESIDENT.

LETTER OF SUBMITTAL.

OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., February 2, 1904.

SIR: I have the honor to present herewith the annual report of the Office of Experiment Stations, which includes a report on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1903.

This is the ninth annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the act of Congress; the printed reports and bulletins of the stations; and the reports of personal examinations of the work and expenditures of the stations made during the past year by the Director, assistant director, and one other expert officer of the Office of Experiment Stations.

In addition to the brief accounts of all the stations, the detailed reports of the special agents in charge of the stations in Alaska, Hawaii, and Porto Rico, and summary statements regarding the special investigations in charge of this Office have been included, together with special articles on progress in agricultural education, farmers' institutes in the United States, instruction in agriculture in land-grant colleges and schools for colored persons, development of the text-book of agriculture in North America, agricultural economics as a subject of study in the agricultural college, experiment station work with apples, a summary of recent American work on feeding stuffs, and organization of governing boards and rules adopted by them for the regulation of agricultural experiment stations.

Very respectfully,

A. C. TRUE,
Director.

HON. JAMES WILSON,
Secretary of Agriculture.

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ANNUAL REPORT OF OFFICE OF EXPERIMENT STATIONS, JUNE 30, 1903.

WORK AND EXPENDITURES OF AGRICULTURAL EXPERIMENT STATIONS.

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SUMMARY.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories and, under special appropriation acts, in Alaska, Hawaii, and Porto Rico. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations, maintained under the act of 1887, during 1903 was \$1,427,237.73, of which \$720,000 was received from the National Government and the remainder, \$707,237.73, from State governments, individuals and communities, fees for analyses of fertilizers, sales of farm products, and miscellaneous sources. In addition to this the Office of Experiment Stations had an appropriation of \$161,000 for the past fiscal year, including \$15,000 for the Alaska Experiment Stations, \$12,000 for the Hawaii Experiment Station, \$12,000 for the Porto Rico Experiment Station, \$20,000 for nutrition investigations, and \$65,000 for irrigation investigations. The total value of additions to the equipment of the stations in 1903 is estimated to be \$236,370.61.

The stations employ 757 persons in the work of administration and inquiry, 375 of whom do more or less teaching in the colleges with which the stations are connected. During the year the stations published 371 annual reports and bulletins, which were supplied to over half a million addresses on the regular mailing lists. A larger number of

stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

PROGRESS OF THE STATIONS.

As the work of the experiment stations advances from year to year experimental data accumulate in many lines, and from time to time results of great general importance come out of this extensive work. A good example of this at the present time is found in the investigations of the stations relating to cheese making. The importance of this industry in this country is shown by the fact that the production now amounts to 300,000,000 pounds a year, valued at approximately \$30,000,000. Though cheese making is probably the oldest dairy industry, very little has been known regarding the principles on which it is based. For centuries it has been carried on largely by rule-of-thumb methods, and the reasons for the various processes and the exact nature of the changes brought about by them have been unknown to the cheese maker. He has been guided mainly by the traditions of his art and has depended upon the skill and judgment acquired through long experience.

Within the past ten years several of the experiment stations of this country have prosecuted systematic studies of cheese making, with a view of determining the principles upon which it rests and the means of simplifying and improving its processes. Owing to the large number of factors involved the work has been difficult, and for a considerable time the progress was slow. Now, however, the accumulated results are of great practical value, and it may be fairly claimed not only that this great industry has been put on a rational basis, but also that the art of cheese making has been simplified and its processes can now be more easily controlled, so that good cheese can be more uniformly produced. Besides providing explanations for the important processes in cheese making, the work of the stations has shown that the traditions upon which the empirical rules were founded were absolutely wrong in numerous important particulars and that the judgment of good cheese makers was also erroneous.

Taken as a whole, the investigations on cheese making by the American experiment stations constitute one of the most important contributions of science ever made to any branch of agriculture. A few of the general results of this work may serve to indicate its practical value.

One of the greatest sources of trouble in cheese making has been milk which is tainted, or which contains certain kinds of bacteria and molds. The milk of a single patron of a cheese factory may unfavorably affect the whole supply by causing gassy curds and other difficulties. To remedy this a simple curd test was developed by the Wisconsin Station a few years ago by means of which faulty milk may be easily detected.

For ages rennet has been used in the production of curd, and it has been supposed that nothing else could take its place. An extended study of the action of rennet by the New York State Experiment Station led to the conclusion that its effects in curd production are due to a single ferment whose action is essentially like that of pepsin. This raised the question whether ordinary commercial pepsin could not be used in the place of rennet. The Wisconsin Station and the Ohio State University have demonstrated that pepsin may be so used with entire success, and tests with pepsin on a commercial scale in an Ohio cheese factory have resulted in the production of cheese of high quality. Some of the advantages of scale pepsin over rennet extracts are that it is of more uniform strength, keeps better, especially in warm weather, and is free from bacteria and molds.

According to the traditions of cheese making, a temperature of at least 70° F. has been considered the proper one for ripening cheese, but investigations have shown that while high temperatures hasten changes in the casein, since ferments and bacteria are then more active, heat also increases the activity of injurious germs and prevents proper control of the ripening. Hence, too warm curing rooms are one of the greatest causes of poor cheese.

Taking up this line of work, the Wisconsin and New York State stations have made extensive experiments in curing cheese at low temperatures, and recently the United States Department of Agriculture has cooperated in this work. Cold curing at from 40° to 60° F. has in this way been shown to be entirely practicable, and to result not only in improved quality, but in a saving from shrinkage which will more than cover the expense of artificial cooling. Cheese makers are now convinced that they have been holding their cheese at too high a temperature, and there is a very general movement among them to provide facilities for lowering the temperature and keeping it down even in the hottest weather.

Another good illustration of the practical value of the accumulated results of experiment station work may be found in the summary of the investigations on apple growing contained in another part of this report. From this it appears that the stations have issued more than 170 bulletins on this subject. Much useful information regarding the best general conditions for apple growing, and the varieties adapted to different localities, has thus been disseminated, but besides this the results of a large number of original investigations have been reported.

Studies of the flowers of apple trees have shown that some varieties of apples are self-sterile, while others are good pollenizers. In this way the unproductiveness of many orchards is explained, and the way to remedy this is pointed out. The conditions under which the pollen germinates, and how this process is affected by heat, rain, and cold, as well as the value of bees as agents in the distribution of pollen, have

been shown. The chemical composition of the leaves, trunk, and roots of the apple tree have been determined both for old trees and for nursery stock, and the draft of the orchard on the fertility of the soil has been shown to be fully as great as continuous cropping with cereals. This has brought out the necessity of fertilizing orchards, and has led to important experiments on the action of different fertilizers on the growth of the apple orchard and of fruit production.

In connection with studies relating to the cultivation of orchards, definite information has been obtained as to the period of growth of the shoots and roots, the time of formation of the flower and leaf buds, and the methods of controlling the ripening of the wood so as to prevent winterkilling. The value of clean cultivation and of fall cover crops in the preservation of soil moisture and the protection of the roots during the winter has been demonstrated, and it may be safely asserted that never before in this country have apple orchards been given such thorough and rational cultivation as at the present time.

How best to plant apple trees in the arid West and the humid East, or on clay soils and sandy soils, right methods of pruning the roots and training the tops, how to ward off diseases and insect pests and produce uniform and perfect fruit, are problems on which much valuable experimental information has been obtained. As the result of station work, we know definitely the controlling factors in the keeping of fruit in ordinary and cold storage, and in the utilization of waste fruit by evaporation, or conversion into cider, vinegar, jelly, marmalade, etc.

The large amount of work which the stations have done on questions relating to feeding stuffs is indicated by the brief review of this work given elsewhere in this report. Some of the practical results of this work have been very important. The saving and use of corn fodder (stover), which was formerly so largely wasted over a large part of the country, is a striking illustration of this. Its value as a feeding stuff has been demonstrated, and the best means of utilizing it have been shown by the stations' work, and their continual agitation has brought about very great improvement in farm practice in this respect. At the nominal value of \$1 a ton the corn stover crop of the United States would be worth at least \$100,000,000. While it is not all utilized, a much larger share of it is, and the practice of doing this is steadily increasing.

The inspection of commercial and condimental feeding stuffs, brought about by the experiment stations, has already had the effect of largely holding in check the adulteration of these products and fraud in their sale. In a number of States where the laws have been vigorously enforced by the stations inferior articles have been entirely driven out of the market, because farmers would not buy them unless they received the stations' stamp of approval.

Along with the more scientific work which the stations have done in determining the nutritive value of feeding stuffs there has been much practical work in the improvement of the practice of feeding different kinds of farm animals. The skill which the stations have developed in selecting and feeding animals has of late appealed strongly to the practical feeder. As recent illustrations of this, it is worthy of mention that the Missouri Station topped the Chicago market with a bunch of steer; which it selected and fattened last winter, and that at the live-stock show at Chicago, in 1903, the grand champion of the fat-animal show was a steer selected from a large lot and fed by the Nebraska Station.

In general it may be stated that the excellent showing that the agricultural colleges and experiment stations have recently made in the great live-stock expositions has brought about a marked change in the attitude of practical men toward these institutions.

NEEDS OF THE STATIONS.

As the work of the stations advances demands are being made upon them in various directions which they are unable to meet with their present resources. In considering the needs as well as in judging the work of the stations it is very important to have in mind the conditions under which they are operating. By the terms of the Hatch Act, the stations are organized with a view to the investigation of problems in all branches of agriculture. For this reason, though it would be better theoretically for individual stations to undertake only a few lines of work and thus refuse to operate in many branches of agriculture, practically it has been necessary to organize them so that their operations may cover the main lines of the agriculture existing in the States in which they are severally located. Thus each station if fully organized would have departments of agronomy (field crops), horticulture, animal husbandry, rural engineering, agricultural chemistry, plant pathology, entomology, veterinary medicine, and, in most States, dairying. If there is any specialization of work in these departments—and no station can do the most effective work unless there is considerable specialization—experts in such subjects as soils, bacteriology, animal physiology, and the different kinds of live stock must be employed. In many States the needs of special industries, such as sugar making, tobacco growing, apiculture, etc., should be provided for. Thus it may be safely said that a station which does not have on its staff experts representing at least ten different branches of the science of agriculture is not adequately equipped for its work. But stations whose income is confined to the Hatch fund can not engage the full time of ten experts, for even if the whole fund were used for salaries, it would provide only an average annual compensation of \$1,500 apiece, and this is not a sufficient salary to secure the entire services of a com-

petent agricultural expert. Most of our stations have therefore been compelled to content themselves with an organization of their staffs which is necessarily unsatisfactory. They have either taken most of the time of three or four experts and very little of the time of several more, or they have taken about half the time of the members of the staff generally.

The only way in which it has thus far been possible to organize the work of our stations broadly has been through their connection with the agricultural colleges. To meet the demand for the broad organization of both the colleges and the stations, the time of the officers of these institutions has been very largely divided between teaching and research. We hear a great deal of criticism of our college and station officers which entirely leaves out of account this dual arrangement. For example, it may be said of a station veterinarian that he is doing very little original work, and he is blamed for this, when the fact is that he is paid only \$200 or \$300 a year from station funds, with the understanding that he shall give a small part of his time to some of the more superficial problems of animal diseases in the region of the station. The rest of his time is given to the college or to State inspection work and most of his salary comes from college or State funds. Theoretically, it might have been better for the station to have dispensed with his services altogether, but the agricultural community would not be content with such an arrangement. Whatever may be thought of the relation of the colleges and stations from an ideal standpoint, it would not have been possible to have operated the stations on the broad plan on which they are now organized without the assistance of the colleges, and on the other hand, many college departments would be crippled or destroyed without the aid of the stations.

During the fiscal year ended June 30, 1902, 52 stations shared in the benefits of the Hatch fund. Twenty-five of these were given additional State aid and 27 did not receive State aid. Of the State appropriations for the stations, 6 did not exceed \$1,000, and only 8 equaled or exceeded the Hatch appropriation of \$15,000. Several of the State appropriations were exclusively for the support of substations. The total State appropriations for stations and substations were but little more than 51 per cent of the Hatch fund.

The meagerness of the funds available for investigation in the 27 stations not aided by the State is shown by the following figures from the statistical reports on the expenditures of the Hatch fund in those stations. Their total receipts from the Hatch fund were \$405,000. Their expenditures for administration and permanent improvements (salaries, labor, traveling expenses, postage, stationery, libraries, and fixtures) amounted to \$313,086.38, or an average of \$11,595 for each station. The average amount expended for publications was \$760. This leaves an average for each station of only \$2,645 for the general expenses of

investigations (chemical supplies, fertilizers, feeding stuffs, tools, implements and machinery, scientific apparatus, live stock, seeds, plants, sundry supplies, freight and express, heat, light, water, and contingent expenses). The stations are organized in a number of divisions representing the different branches of agriculture and related sciences; the average number of investigators employed by each station is 10. Dividing the sum available for general expenses by the number of investigators we have an average of \$264.50 for each investigator. The whole amount (\$2,645) would hardly pay the expenses of a good-sized feeding experiment or a field experiment involving tests in several different localities. How inadequate, then, does such a sum appear to be when divided among 10 investigators. Under these conditions it is not strange that so many problems of the farm remain unsolved; it is wonderful that so much has been accomplished by our smaller stations.

These figures show conclusively that, if our stations are to be continued on the broad basis on which they are at present organized, they must generally be supplied with larger funds for the general expenses of investigations, in order to conduct their work in a thorough and satisfactory manner.

As soon as any station demonstrates its usefulness by results which promote any agricultural industry within a State all the other industries cry out that the station must do work on their problems. At first an attempt was made to meet these demands by the publication of compiled bulletins which might contain considerable information more or less new to most of the readers, but in most cases this is no longer of much avail. Some stations have tried to satisfy the most urgent of such demands by doing a little work on a variety of problems, but as a rule this has been unsatisfactory to all concerned. There is not a station in the country which is not confronted by reasonable demands for investigations of important agricultural problems which at present it is wholly unable to satisfy. In the older States the changing conditions of agriculture have created many problems which are new to the farmers and on which they greatly need help, and in the newer States the extension of agriculture is so rapid that the stations are unable to keep pace with the wholly unfamiliar problems that arise in the farmers' new fields.

In this connection it is well to consider that the areas over which many of the stations in this country are required to extend their jurisdiction are so large that they can not meet the demands for investigations adapted to the various conditions of soil, climate, and rational agricultural practice in their several States. The investigations thus far carried on by the stations in many lines have very clearly brought out the fact that there is a large number of agricultural problems which must be studied in numerous localities before safe conclusions can be drawn. This is especially true with reference to problems relating to

the character and management of soils, the use of fertilizers, and the growth of varieties of field and horticultural crops. A large share of the work already done on these subjects by the stations needs to be supplemented by experiments carried on in different parts of their respective States, but this they are unable to do. The greatness of the agricultural regions in whose interest our individual stations are working is rarely realized. Even along the Atlantic coast we have on an average only one station for each 24,000 square miles; France and Germany have eight times as many. The South Central States with their 10 stations are 40 per cent larger than all of France and Germany with their 151 stations; and Texas alone, with one Federal station, is 27 per cent larger than either of these countries. The ratio of stations to area in France and Germany is 96 to 1 as compared with Texas, 28 to 1 as compared with Minnesota and the Dakotas, and 39 to 1 as compared with the Pacific States.

Some of the States have tried to meet the local needs of agriculture by the establishment of substations, but as a rule the funds provided for this purpose have been entirely inadequate.

When the Hatch Act was passed, less than twenty years ago, no country had established experiment stations on the broad plan set forth in that act. The success of our stations has thoroughly demonstrated their usefulness. At the same time, they have shown possibilities for the useful extension of their work which were not at all understood when the Hatch Act was passed. Aside from the needs of the stations growing out of the greater specialization of their work which calls for the employment of a larger staff, the cost of their equipment with laboratories, apparatus, and other facilities has greatly increased, and the demands for the information which they are able to supply have made the expenses connected with the printing and distribution of their documents much greater than in the early years of their history. An enormous correspondence with farmers has also been developed which must be provided for, and is now in many cases a hindrance to the research work of the staff because of lack of funds for clerical assistance.

In these and other ways the magnitude of the station work at the present time is in itself an important item as related to their financial needs. If the individual stations needed \$15,000 per annum for their work a decade or more ago, they certainly need a much larger sum to carry on their work to the satisfaction of the agricultural community at the present time.

The work done by the stations in various lines has brought out clearly the necessity for more fundamental investigations, but such investigations as a rule are costly and only a few of our stations have been able to undertake them. The stations, for example, have made numerous feeding experiments with different kinds of farm animals.

Many of these have had useful results, and the work of the stations on this subject as a whole has done much to improve the practice of feeders, but it will be impossible to put this practice on a thoroughly rational basis until we know much more regarding the physiological requirements of animals. Some years ago one of the stations undertook investigations looking to the improvement of the apparatus necessary for the thorough investigation of the nutrition of man. It soon appeared that it could not carry this work to a successful issue without larger resources than it possessed, and it therefore sought the cooperation of the United States Department of Agriculture, with whose aid a special fund was obtained from Congress for this investigation. The work thus inaugurated and maintained resulted, after several years, in a more efficient apparatus than had hitherto existed for this kind of inquiry. By its use our knowledge of the laws of nutrition and the nutritive value of different foods has been materially extended. After this apparatus had been completed, another station undertook to adapt it to use in experiments with large domestic animals. This enterprise proved too great for the limited funds of that station, and again the Department of Agriculture was called upon to contribute thousands of dollars to make the work a success. Through this cooperation the apparatus was put in working order and a series of experiments has been begun which promises to yield very important results.

As long as the stations confined their studies of the varieties of cultivated plants to simple tests of the varieties already produced, the work was comparatively inexpensive and very largely unsatisfactory. Now the breeding of varieties especially adapted to particular regions and uses has been attempted, but only those stations which are supplied with extra funds for this purpose can hope to accomplish much in this line.

Very little has been done in this country in the scientific breeding of animals, and we are as yet largely dependent on importations of breeding stock from foreign countries to maintain the quality of our meat and other animal products. The production of breeds of farm animals especially adapted to the needs of different parts of our country has hardly been attempted. The stations are the public agencies to which such work would naturally be entrusted, but, with one or two exceptions, they have no funds available for this purpose.

In veterinary medicine very few of the stations have been able to provide the equipment necessary for the successful prosecution of original researches. They have therefore been obliged to content themselves very largely with the diffusion of information derived from investigations made elsewhere and the more superficial study of cases of diseases brought to their notice. There is, of course, a large field for the extension of the work of the stations in this direction, but it can not be done without increased funds.

Under present conditions it is useless to expect that in these and many other lines our stations will discover many of the principles on which the permanent improvement of our agriculture must rest. But unless the way is opened for them to seriously attack these fundamental problems their future work will necessarily be comparatively fragmentary and inconclusive. They may, as in the past, obtain many results which can be usefully applied in practice, but they will not be able to furnish a solid foundation for the enlargement of our agricultural industries. The recent work on cheese making, which has been briefly summarized elsewhere in this report, is a good illustration of what may be accomplished in many lines if the financial resources of the experimenters are adequate for the work undertaken by them. By means of investigations costing thousands of dollars and extending over a number of years the interests of an industry which is now large, but which is likely to be very greatly extended in the future, have been permanently and advantageously affected. The economy of using relatively large sums of money in fundamental inquiries has thus been signally shown.

As pointed out in previous reports, there is another side of the work of the stations which needs to be greatly extended. It is, in many cases, not enough that the stations should discover new facts and principles. They must show definitely how these can be utilized in agricultural practice. This requires that they should be in a position to work outside of their laboratories and experimental plats. They must carry on experiments under actual farm conditions, and on a really practical scale, before it can be truly said that they have demonstrated the usefulness of their new discoveries. It used to be said that this was not the function of the stations, but that the farmers themselves must demonstrate the practical usefulness of the results obtained by the stations. There is, of course, a sense in which this will always be true, for the conditions of no two farmers are exactly alike, and whatever the stations do the farmers will still need to adapt the results to the requirements of their own farms. But, on the other hand, it is often a very expensive proceeding to the farmers to undertake to apply results obtained by the stations on a very small scale to even the general requirements of farm practice. It is usually true that laboratory and plat results must be modified in various ways to make them practically serviceable, and this can be much more economically done by the stations than by the farmers. For example, if a station breeds a new variety of grain, it would be much better and less expensive for the station to retain control of this variety and carry on field experiments with it on a considerable number of farms in different localities than if the seed is at first distributed to farmers indiscriminately. Much of this more practical work can be carried on in cooperation with farmers, but to do it efficiently will require more funds than the stations at present possess.

Since the stations were established under the Hatch Act, the States have materially increased their appropriations for their maintenance, and it may be asked why should not the States be called upon to add to the resources of the stations whatever additional funds are needed for their more perfect development. In reply to this it may be said that there are likely in the future to be such demands on the States to provide for the extension of agricultural education in general that it will be increasingly difficult for them to add to the resources of the stations. This has already been the case in a number of States. Thus far, in most of the States, the stations have been aided by appropriations for buildings and equipment which have been for the joint use of the agricultural colleges and experiment stations. The increased interest which is now being manifested in those forms of education which are furnished by the agricultural colleges has had the result that the number of students in those institutions is increasing more rapidly than the facilities provided for them. This is putting additional burdens on the officers of these institutions, many of whom are employed in both college and station, and is making the new buildings inadequate for the purpose for which they were intended. Moreover, outside the colleges there is a rapidly growing demand for secondary schools of agriculture and the introduction of agricultural subjects into the public schools. The States will therefore need to provide largely increased funds for agricultural education, and this is likely to absorb their revenues to such an extent that it will not be practicable for them as a rule to materially increase the resources of the stations.

Thus far the stations have been maintained mainly by National funds, and this policy having been once adopted it seems reasonable that the nation should increase its contributions to the support of these institutions as the demands of their work increase, and thus leave the colleges more free to advance the agricultural education of the people with the aid of State funds. This argument has more importance from the fact that the results of the work of the stations are more and more depended on to furnish the materials on which courses of instruction in agriculture of different grades can be successfully based. If the nation makes the institutions of research in agriculture strong and far-reaching in their work, it will thereby lay the foundation for a system of agricultural education which, if the States and local communities do their duty, will eventually profoundly affect the material and intellectual well-being of the masses of our rural population.

The theory on which appropriations of public money are made to the agricultural colleges and experiment stations is, that since these are institutions for the promotion of an industry on whose success the whole fabric of the nation's material prosperity depends, all our people

are interested in and affected by the results of their work, and therefore it is proper that the people generally should contribute to their maintenance. If such a theory was reasonable when the value of the work of the experiment stations was problematical, it should certainly be much more effective now that they have proved their great usefulness as agencies for the promotion of agriculture throughout the United States.

STATISTICS OF THE LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1903 is estimated to be \$69,778,463.25. The income of these institutions in 1903, exclusive of the funds received from the United States for agricultural experiment stations, was \$9,248,378.40. The value of the additions to their permanent endowment and equipment in 1903 is estimated to be \$2,743,683.38. The number of persons in the faculties of the colleges of agriculture and the mechanic arts was 2,461, and in other departments, 1,141, making a grand total of 3,602. The number of students in 1903 was 52,489, of whom 3,146 were in four-year courses in agriculture and 7,550 in shorter courses in agriculture, dairying, horticulture, and veterinary science. The graduates in 1903 were 4,524, and since the organization of these institutions, 53,252.

PROGRESS IN AGRICULTURAL EDUCATION.

The advance movement in agricultural education in this country has continued during the past year and is exerting a constantly widening influence. Results of agitation along these lines are seen in many ways. Provision for the higher education of agricultural experts is being made in larger measure in the Department of Agriculture and in some of our strongest agricultural colleges. There is a continued demand for the establishment of a National graduate school of agriculture on a permanent basis. The regular courses of the agricultural colleges have been more liberally equipped through enlarged appropriations by the State legislatures, and these courses are becoming much more effective through increasing specialization of instruction and its extension to include such subjects as rural engineering and rural economy, which have hitherto been largely neglected in these institutions.

The colleges are also making larger provision under their direct auspices for secondary schools, short courses, summer schools, normal courses, correspondence courses, farmers' institutes, and other forms

of university-extension work. They are thus meeting the needs of a much larger body of students, and are at the same time putting into shape courses of instruction which are destined to be followed in many other institutions throughout the country.

During the past year a number of separate agricultural schools of secondary grade have been established under public or private control. Discussion of questions relating to the improvement of the rural common schools and the introduction in them of elementary courses in agriculture has taken a wider range. The general officers of education and the teachers' associations in the different States are earnestly considering these matters, and the farmers' organizations are increasing their demands that definite provision for such instruction shall be made in the public schools. Already a number of States have special legislation relating to this subject. Courses for the instruction of teachers have been established in a number of agricultural colleges and normal schools, and under various forms instruction in agricultural subjects is already given in a considerable number of elementary schools in different parts of the country. One of the most encouraging features of this movement is the appearance of a number of text-books prepared especially for elementary instruction in agriculture. It is now possible for the intelligent and sympathetic teacher to readily obtain the information necessary to make such courses a success.

In these various ways the movement to make instruction in agriculture a regular feature of our public school system has received great impetus. There must of course be a period of experimentation in which the methods of instruction and the text-books shall be tested and improved. There is always danger when a movement of this kind gets under way that it will proceed to extremes with a resultant reaction. Against this the friends of agricultural education should be on their guard, but they can now more confidently than ever before assert the claims of agriculture to recognition in our public school system and justly claim that the means are at hand for making a fair and thorough trial of elementary instruction in this subject in these schools.

THE FARMERS' INSTITUTES.

During the past year 3,179 farmers' institutes were held in 46 States and Territories. The total attendance at these institutes was over 900,000. Appropriations varying from \$35 in the Territory of Hawaii to \$20,000 in the State of New York were made for the support of the institutes, the aggregate for 45 States and Territories reported being \$187,226. The institutes were addressed by 924 lecturers, employed by the State directors, and by about three times as many more employed by the local managers, making a total approximating 4,000 persons who gave instruction at the institutes during the year. One

hundred and ninety-six of these were members of the agricultural college or experiment station staff, who contributed 1,666 days of time to this work, attending in all 752 institutes.

The eighth annual convention of the American Association of Farmers' Institute Workers was held at Toronto, Canada, in June, 1903, and was attended by delegates from seventeen of the States of the Union and four of the provinces of the Dominion of Canada. The proceedings of this convention have been published as Bulletin No. 138 of this Office. An account of this convention is given on page 57.

The work of this Office relating to the farmers' institutes has been put on a permanent basis during the past year, and a special officer has been appointed to take charge of this work. The duties of this officer, as stated in the act making the appropriation for this work, are "to investigate and report upon the organization and progress of farmers' institutes in the several States and Territories, and upon similar organizations in foreign countries, with special suggestions of plans and methods for making such organizations more effective for the dissemination of the results of the work of the Department of Agriculture and the experiment stations, and of improved methods of agricultural practice."

Since the work of this Department relating to the farmers' institutes is based on the principle of giving aid to the institutions maintained under the authority of the States, this Office has established the rule of working in this line through the State officers charged with the management of the institutes. It is the intention to consult freely with these officers, to welcome suggestions from them regarding the development of our work, and to recognize them as the proper authority through whom to deal in matters relating to the institutes in the several States. It is our purpose to endeavor to strengthen the State organizations for the management of the institutes, and to create a national system of institutes by promoting the reasonable coordination of the work throughout the country and the cooperation of the State organizations without weakening or destroying their autonomy.

Considering the conditions under which our work must be performed, it is our intention to concentrate our efforts for the present on a few of the most pressing lines in which it appears that the institutes need the aid of this Department. It is generally agreed among institute managers that the most urgent problem in institute work just now relates to the securing and maintaining of an efficient corps of institute lecturers. The longer farmers attend the institutes the more they demand that the lecturers shall not confine themselves to stating individual experiences, however successful these may have been, but shall interpret to them the teachings of wide practical experience as related to the results of experimental investigations conducted under scientific direction. This means that the lecturers must be constant

students of the progress of practical and scientific agriculture. They must, therefore, have the means of acquainting themselves readily and satisfactorily with what is going on throughout the world in the line of their specialties. Besides this, they must be provided with the best facilities for the clear presentation of their subjects to their audiences. This means that they must have the right kind of specimens, charts, photographs, lantern slides, etc.

This Office, therefore, intends to give much attention to whatever concerns the best training of the farmers' institute lecturers. It will also aid the institute managers to secure the best available lecturers in the different branches of agriculture.

In the appropriation act making provision for the work of this Office in relation to the institutes it is made our duty to bring the results of the work of this Department before the farmers attending the institutes. As a result of this provision we are already receiving numerous calls for the personal attendance of officers of the Department at the institutes. These calls are welcomed as evidences of the public interest in the work of the Department, and special pains are being taken to meet them satisfactorily as far as possible. In this way it may be expected that the Department will be much more generally represented at the institutes in the several States than it has been in the past, and the work of the Department will be explained to thousands of farmers who hitherto have had only vague understanding of its relation to practical agriculture. Since it is obviously impracticable for the Department to be personally represented at all the institutes, the plan will be followed of sending its representatives especially to the round-up institutes and such other meetings of large numbers of representative farmers as will be likely to secure the most effective dissemination of information regarding the Department's work in different sections of the country.

It is difficult to realize the extent and importance of the farmers' institute movement and its vital relation to the successful incorporation of the results of scientific investigations in our agricultural practice. Under present conditions, with the rapid changes in the personnel of our agricultural population and the almost entire absence of agricultural instruction in our elementary schools, it is of the greatest importance that our adult farmers shall receive definite information regarding improved methods of agriculture and the principles which lie at the foundation of progress in agricultural practice. Already it is estimated that nearly 1,000,000 of our farmers are reached at least to a limited extent by the institutes. To give this great body of men sound instruction, and to bring the remaining 9,000,000 farmers of the United States within the direct influence of the institutes, is a vast undertaking. Considering the very limited funds which the institute managers have had at their disposal they

have accomplished wonders. And when the public and our legislators understand the significance of the institute movement in its relation to the mental and material well-being of our people there will be no difficulty as regards funds for the proper development of the institutes.

It was doubtless necessary to gather the data for the science of agriculture through the work of the Department and the experiment stations, and to train the leaders of agricultural progress in our agricultural colleges, before it was possible to put popular movements for agricultural education on an effective basis. But the time is now ripe for a great advance movement for the wide dissemination of agricultural knowledge among the masses of our people. Workers must be trained for this purpose, but they will come with the enlargement of the demand for them. Wise provision for the maintenance of these workers by Congress and the State legislatures will bear abundant results in popular approval and the advancement of the national interests. Intelligent and active leadership in this cause will prove very effective at this juncture, and all who are in a position to render valuable service in this line have good reason to believe that their efforts will be crowned with early success.

THE ASSOCIATION OF COLLEGES AND STATIONS.

The Association of American Agricultural Colleges and Experiment Stations held its seventeenth annual convention at Washington, D. C., November 17-19, 1903. This meeting was more largely attended than usual and was notable for its harmony and the expedition with which business was transacted. Amendments to the constitution were adopted which, it is believed, will make the association more effective as an administrative body and permit the more thorough discussion of the general questions relating to the organization and policy of the educational and research institutions comprising the membership of the association.

The work of the standing committees of this association is assuming larger importance. In this way the matters in which the association is especially interested are being much more effectively dealt with than if their discussion were confined to the annual meetings. A brief account of the Washington meeting is given on page 50.

THE OFFICE OF EXPERIMENT STATIONS.

The business of the Office of Experiment Stations has continued to grow during the past year, and several new features have been especially developed. Work in relation to the farmers' institutes has been put on a permanent basis, and systematic efforts are being made to bring the Department into close relations with the State organizations through which the institutes are managed.

In the work of the Office relating to agricultural education special emphasis has been placed on encouraging the establishment of secondary and elementary courses in agriculture, and to aid this movement publications have been issued showing the progress already made in these lines. Advantage has been taken of a considerable number of opportunities to bring these matters directly to the attention of teachers at meetings of their associations in different parts of the country.

The Office has continued to have charge of the agricultural experiment stations in Alaska, Hawaii, and Porto Rico, and of the nutrition and irrigation investigations which are conducted in different parts of the country, largely in cooperation with the agricultural colleges and experiment stations.

In cooperation with the Association of American Agricultural Colleges and Experiment Stations, the Office has undertaken a large amount of work in connection with an exhibit of the progress of agricultural education and research at the St. Louis Exposition.

With the development of the work of the experiment stations and kindred institutions in this country and abroad, the publications of this Office based on the reports of these institutions have increased in number and variety. Results of the special investigations in charge of this Office have also accumulated so as to afford more material for useful publication. For these reasons, the extent of the publications of the Office has increased during the past year. Special efforts have, however, been made to publish this material in forms which will contribute to its effective and economical distribution.

The records of the Division of Publications for the fiscal year ended June 30, 1903, show that out of a total of 456 original publications issued by the Department during that year 123 were from this Office, and that 132 of our documents were reprinted out of a total of 482 for the Department. The aggregate number of copies of publications of this Office issued during the year was 2,255,400 out of a total of 11,698,564 for the Department. Of these publications 1,998,000 were Farmers' Bulletins prepared in this Office.

From this statement it will be seen that the Office is doing a large work in providing means by which the results of agricultural investigations made by our State experiment stations and kindred institutions throughout the world can readily be made use of by farmers throughout the United States.

A brief account of the general business of the Office will be found on page 60, and details of its operations are given in other portions of this report.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

In Alaska experiment stations were maintained during the past fiscal year at Sitka, Kenai, and Rampart. A new station was established at Copper Center, and cooperative investigations were carried on in a

number of localities. In this way considerable additional evidence was obtained that vegetables of various kinds may be successfully grown in different parts of the Territory, and that there are considerable areas in which oats, barley, and wheat can be matured, and an abundance of grass be grown for the maintenance of live stock.

Important testimony regarding the agricultural possibilities of Alaska has recently been given by Gen. A. W. Greeley, Chief Signal Officer of the United States Army, in a letter to the Secretary of Agriculture, in connection with which he transmitted samples of vegetables grown in the garden of Gov. John G. Brady, of Sitka, Alaska. In this letter he makes the following statements:

They are **not** hothouse plants nor are they simply examples, but they are part of large quantities of vegetables—potatoes, turnips, carrots, parsnips, beets, onions, and celery. Fully 200 bushels of potatoes of the finest possible character were grown in this garden during the past summer. They are illustrations of the capabilities of Alaska as regards the growth of vegetables.

To my knowledge large quantities of similar vegetables are grown in the valley of the Yukon, especially in its lower part.

I do not compare the agricultural possibilities of Alaska with those of the United States, but feel confident from personal observation that there are thousands of square miles which are admirably adapted to the growth of vegetables and forage in large quantities and for the local market.

In Hawaii the station at Honolulu has increased its equipment and extended its experimental investigations. The experiments on taro rot and potato rot have been continued upon an enlarged scale. One of the diseases of the taro plant was held in check by proper attention to irrigation water and the application of proper fertilizers. The results obtained will have an important bearing on the production of this staple food crop.

Experiments to promote the improvement in corn culture on the island of Maui have been begun, and important studies of injurious insects have been made. Experiments have also been undertaken with fiber plants, vanilla, cacao, cotton, and tobacco.

Members of the station staff have from time to time visited the different islands for the purpose of investigating specific problems, and of attending farmers' institutes which have been held in a number of localities and have been very successful. The legislature of Hawaii has appropriated \$16,800 toward the support of the station for the two years ending June 30, 1905.

In Porto Rico much attention has necessarily been given during the past year to the repair of buildings on the new station farm at Mayaguez, the preparation of land, and the inauguration of experiments. Special attention has been given to the establishment of plantations of tropical plants, including such things as mangoes, alligator pears, the mammee apple, cassava, yams, bananas, cacao, and citrus fruits. Experiments with coffee have been carried on during the year and the

results of the application of fertilizers have been marked. Bat guano secured from caves on the island has given better results than any of the commercial fertilizers.

The cordial support which has been accorded the station by the people and legislature of Porto Rico has been very encouraging.

The details of the work of the stations in Alaska, Hawaii, and Porto Rico may be found in the reports of the officers in charge of these stations, on pages 313, 391, and 419.

NUTRITION INVESTIGATIONS.

The nutrition investigations have as hitherto been devoted mainly to a study of the physiological, hygienic, and economic branches of the subject, and have included dietary studies and digestion, cooking, and metabolism experiments. These studies have been carried on in cooperation with universities and experiment stations in California, Connecticut, Georgia, Illinois, Maine, Minnesota, and Tennessee. In cooperation with the Department of the Interior dietary studies were carried on in the Government Hospital for the Insane in the District of Columbia. These investigations were inaugurated at the desire of the late Dr. A. B. Richardson, superintendent of the Government hospital, as a part of his general plan for maintaining a high standard for the conditions under which the patients and employees live in this institution. Twenty-seven dietary studies were made in all with about 1,600 male patients and 125 employees. Some of the general results of these investigations are stated in the report of the board of visitors of the hospital to the Secretary of the Interior for 1903, as follows:

It was noted in connection with these investigations that the food purchased was of good quality; that it was stored, handled, and cooked in a cleanly way, and that the service was as good as could be expected under existing conditions. * * * So far as its nutritive value is concerned, the dietary was found to be adequate and reasonably satisfactory. The criticisms made had to do with details rather than with the system as a whole. So far as its cost is concerned, it is higher than seems needful on theoretical grounds, or than that of a similar diet at other institutions. From time to time as the dietary studies were in progress, changes were pointed out which would check waste in certain directions, and these were promptly acted upon by the late superintendent, who stated that, in his opinion, as a result of these investigations the cost of the food during the last six months of the year was lower than for any other corresponding period during his connection with the institution.

Similar studies are being continued this year. A further account of these investigations may be found on page 503.

The work with the respiration calorimeter, carried on at Middletown, Conn., has been largely devoted to the modification and improvement of the apparatus. In its modified form it is possible to make a more accurate determination of carbon dioxide and water and a still more important feature, a direct determination of oxygen, which has been

made possible by changes in the apparatus made under a grant from the Carnegie Institution.

Considerable additional data regarding the nutritive value of fruits and nuts have been obtained, and a report on this subject has been published. Additional data on the digestibility and nutritive value of bread have also been published, and, as the result of the investigations of this Office on this subject, it has been clearly shown that ordinary wheat flours are thoroughly digested and have a high nutritive value.

Six bulletins recording the results of nutrition investigations were published during the past year.

IRRIGATION INVESTIGATIONS.

The investigations carried on during the past year by this branch of the Office of Experiment Stations, as provided for by Congress, may be grouped under the following heads:

(1) The determination of the amount of water needed in irrigation and the methods of applying it to crops to secure the best results.

(2) The improvement of methods of distribution in order to lessen the cost of water to farmers, and reduce the waste from evaporation and the loss and damage caused by excessive seepage.

(3) Investigations of drainage problems (*a*) to prevent the injury of irrigated land through the accumulation of surplus and seepage waters, and (*b*) to reclaim swamp and overflowed lands by aiding farmers in the settlement of general drainage problems.

(4) Investigations of the best means of applying power in pumping and other branches of farm work.

(5) Studies of irrigation institutions, including the laws and customs under which rights to water are acquired and enforced, and the corporate and cooperative institutions which affect the economic relations of water users.

The irrigation investigations have been conducted largely in cooperation with agricultural colleges and experiment stations, State engineers' offices, and organizations of citizens, and during the past year have been conducted in the following States:

California, Nevada, Oregon, Washington, Idaho, Montana, Utah, Wyoming, Colorado, Nebraska, Kansas, South Dakota, Missouri, Wisconsin, New Jersey, Louisiana, Texas, and South Carolina.

THE DUTY OF WATER.

Along many streams in the West the irrigated area has been extended until there is not water enough to supply the lands already under cultivation except through the adoption of most skillful and economical methods of distribution and use in irrigation. This means that the losses in canals due to seepage and evaporation must be lessened, that lateral ditches must be planned and built with more care

than formerly, and that farmers must study, in a way not necessary when irrigators were few and the water supply abundant, the best means of spreading the water over their fields. They must do this in order to lessen losses from evaporation, increase yields, and prevent damage to the land either through the rise of alkali or the creating of swamps and marshes in areas where natural drainage is imperfect and artificial drainage has not been provided.

With the growing necessity for better systems of distribution and application and the increasing price of water, the need for its more accurate measurement is becoming more and more manifest. In other words, the next step in the development of irrigation in the West is largely dependent upon the adoption of better methods and practices on the part of farmers, and this Office is being looked to for aid in the discovery and substitution of these better practices for the ones hitherto followed. For this reason the character of the practical studies carried on by this Office has largely changed within the last two years. The first step in this investigation was to determine the requirements of irrigation under the methods in common use. The next step was to discover better methods of application. The investigations already made have shown that from one-fourth to one-half of the water diverted by canals is lost by seepage, reducing the areas irrigated and the productive value of the canals, as well as rendering unproductive for the time large tracts of land.

The measurements made in California in 1903 show how much the duty of water may be increased by the adoption of better methods. Where water was applied to the hot surface soil, 93 per cent disappeared in evaporation; where it was applied in shallow furrows, 83 per cent was lost; where it was applied in deep, narrow furrows, only 62 per cent was lost. In all cases the loss was sufficiently large to warrant the belief that the water now used to irrigate one acre will in time serve to irrigate two acres.

METHODS OF DISTRIBUTION OF WATER.

Another step in the improvement of irrigation methods is the better organization of communities in the distribution of water. When all the water is needed wasteful or unskillful use by one farmer means inevitable loss to a neighbor. Where all the water is sold or rented uncertainty of measurement almost always results in one farmer getting more than he pays for and another farmer getting less. The construction of storage works to supplement the natural flow of streams and the important agreements being entered into in Colorado, Utah, and elsewhere for exchanges of rights to the natural flow of streams for rights in reservoirs are making the measurement of water an important factor in the success of farmers and in the maintenance of peace and harmony in communities of irrigators. Hence a study of methods of

water measurement and the working out of systems of division of the water supply between the canals and reservoirs and the communities dependent on them are becoming more and more important features of the work of this Office.

The structures used in the measurement and distribution of water are undergoing as important changes as the methods employed by farmers in applying water to their fields. The use of wood in flumes, head gates, and measuring boxes is being done away with, and metal, stone, and concrete structures are being substituted. The pioneer canal builders had to construct wooden flumes and wooden head gates, because this in many cases was the only available material, and it was always the cheapest. Experience, however, has shown that wooden flumes are leaky, expensive to maintain and operate, and their rapid decay makes their apparent economy a matter of grave question. Along with the growing appreciation of their disadvantages has come a remarkable advance during the last four or five years in the manufacture of concrete structures, especially of concrete strengthened by metal. The increasing use of this material in buildings promises to be duplicated in irrigation, and it bids fair to largely displace wood in the construction of flumes, pipes, culverts, and in many sections in the lining of canals to prevent excessive losses from seepage. This Office can render irrigation development no greater service than to collect and collate the results of practical experience in the use of concrete, stone, and metal, and in making tests to determine their efficiency and cost in cases where improvements wait upon more definite information than is now available.

IRRIGATION IN THE SEMIARID REGION.

In the semiarid region which extends from Canada to Mexico, through the western parts of the Dakotas, Nebraska, Kansas, Oklahoma, and Texas, the rainfall in many years is sufficient to produce good crops, but in other years it is not, making agriculture, where rainfall is the sole dependence for moisture, a hazardous industry. This is a region of few streams, and the water supply must therefore be obtained from other sources, such as the storage of storm waters, pumping from wells, and from artesian wells. Experiments were carried on at Hays City, Kans., and data as to the cost of artesian wells and the profits from their use in the James River Valley, South Dakota, were collected. Both in Kansas and South Dakota irrigation has proven very profitable, and it is believed that the methods used in these two localities have wide applicability to the semiarid region.

IRRIGATION IN THE HUMID REGION.

The importance of irrigation in the humid portions of this country is illustrated by the effect of its adoption in the rice districts of Louisiana and Texas. In 1903 more than half a million acres of land was

irrigated in these two States, and the crop grown thereon had an estimated value of more than \$14,000,000, or nearly \$30 an acre. In other words, the value of the single crop is far greater than the total value of this land before irrigation was established.

The success of cranberry irrigation in Wisconsin and elsewhere promises equally important additions to the productive capacity of lands in the North. Irrigation is destined to be a large factor in market gardening and in the production of forage crops everywhere throughout the East. Northern Italy has a rainfall equal to that of the Mississippi Valley, yet millions of dollars are being spent in the construction of irrigation works, not to make agriculture possible but to make it profitable, and there seems to be no reason why irrigation can not be employed in many of the humid sections of the United States with equal benefit.

PUMPING AND DRAINAGE INVESTIGATIONS.

The rapid advance in the use of pumps in irrigation and the lessening cost of pumping, due to utilization of new forms of power, have also opened up a wide field in which this Office can aid farmers in determining how best to utilize small water supplies and be a great factor in the extension of irrigation in both the arid and humid sections of the country.

The large areas of land which were being swamped through leakage from ditches and seepage from higher irrigated land led to the beginning of drainage studies. These problems differed from those of ordinary farm drainage and required special study. The inauguration of this work, however, brought to light the importance of farm drainage in many sections of the East, and the demands upon this Office for investigation of these problems have become so great that the work now being done in humid regions exceeds that being done in irrigated districts. During the past season definite projects, which involved an outlay of about \$1,400,000, were considered by the experts of this Office. Considerable time was given to a study of drainage conditions in Iowa, where it is estimated that lack of drainage caused an injury to the corn crop last year of more than \$4,000,000. Here the relief of the swamped areas involves not only the preparation of comprehensive plans, but the framing of legislation which will enable the people of relatively large districts to work together in constructing and maintaining the needed works.

ECONOMIC STUDIES.

The only new work in our studies of legal and social problems inaugurated during last year was in compliance with the provision of the last appropriation bill requiring this Office to study the laws affecting irrigation and the rights of riparian proprietors. After consulting

the governors and attorney-generals of Kansas, Nebraska, Wyoming, and Colorado, and the State engineers of Nebraska, Wyoming, and Colorado, it was concluded to take up a study of the legal and social problems created by the diversion and use of the Platte River in irrigation, the plan being to gather the facts showing the number of ditches, areas irrigated, character of the rights acquired under the laws of appropriation, influence upon the flow of the stream of the diversion of water by canals and its return in seepage through streams and springs, and the influence of this interference with the natural flow on the rights of farmers and mill owners owning riparian lands in the portions of the stream's course where the riparian doctrine is recognized. The inauguration of this investigation was warmly welcomed by both State officials and farmers concerned. The collection of data has been a laborious undertaking, and it is probable that another season will be required for its completion. It is believed that this report will throw much light upon many of the important practical questions which must be considered by the United States circuit and Supreme courts in the litigation now pending before those tribunals.

A more extended account of the progress of the irrigation investigations during the past year may be found in the report of the officer in charge on page 469.

RURAL ENGINEERING.

The opportunities for this Department to do useful and effective work in studies of other branches of rural engineering are every year becoming more numerous and important. These include the laying out of farms so as to permit of the establishment of systems of rotation, and the economical cultivation and harvesting of crops; the construction and grouping of farm houses and farm buildings so as to secure efficiency and economy and contribute to the healthfulness and attractiveness of rural life. In the movement of settlement to the West and the continued extension of civilized life to regions before unoccupied these matters have been largely neglected, and there is no doubt that, in these particulars, the convenience and attractiveness of farm homes in this country are inferior to those in most European countries. It is equally certain that the betterment of these conditions will have much to do with checking the movement from the farms to the cities.

In the construction of farm buildings, both barns and houses, the farmer is now almost entirely dependent on his own knowledge and ingenuity, and as a result the majority of farm buildings are unsatisfactory, whether considered from the standpoint of appearance, durability, or adaptation to the needs of their occupants. Some problems in connection with farm buildings need careful study in order to improve their healthfulness and convenience. One of these is ventila-

tion. We do not know either the effect of poor ventilation or the most efficient means of securing good ventilation. Another is the improvement in the water system of both farm houses and farm barns. Heretofore, nearly all farm buildings have been built of wood. A change to other materials is inevitable in the near future. Timber is becoming scarce and costly and must be supplemented by brick, stone, and cement. On the other hand, improvements in the manufacture of cement and in the methods of utilizing it for different construction purposes have been one of the most marked developments of recent times. This Department can render the farmers of this country no greater service than by showing just how far it is possible for farmers to make use of these advances in our industrial methods by determining the relative cost and value of different materials to be used in the construction of houses, barns, fences, and other features of the equipment of a modern farm.

It is believed, however, that the greatest opportunity for the improvement of the agricultural practice of the United States is to be found in the right selection and care of farm machinery. In no other country is its use so extensive, and the scarcity and high price of farm labor will tend to its increased use in the future, rather than otherwise. The total value of implements and machinery on the farms of this country, according to the recent census, was \$761,261,550, an average of \$133 per farm, taking the country over, and of 90 cents per acre of farm land. Much of this machinery is elaborate and complicated in construction, and requires mechanical skill for its most efficient operation and care, not to mention the making of small repairs. It represents an important part of the farmer's invested capital upon which he must pay or earn interest. That there is an enormous waste of money due to neglect and unskillful handling of this part of the farm equipment must be obvious to anyone who has traveled through the regions where it is most used.

The record of two tenants on neighboring farms in Nebraska is a case in point as showing how much of this waste may be avoided. These two men have been living on the same farms for the past nine years. One of them is still using the same harvester which he purchased the first year he took the farm; the other has bought and "worn out" three self-binders. In eight and a half years there has been a difference of \$1,900 in the outlay for farm machinery by these two men. Both farms are about equally equipped. The difference is that, as a result of better care and more skillful use, one man's tools have lasted about three times as long as the other's. Such examples of extravagant management are by no means uncommon. The American farmer, with all his mechanical aptitude and inventive skill, has been strangely neglectful in his management and care of agricultural machinery, and until recently there has been little demand for studies

of this subject by this Department and the agricultural colleges of this country.

In Germany, France, and more recently in England, a well-equipped laboratory for testing agricultural machines and a museum filled with samples of machines of different patterns for examination by students is held to be as essential to proper instruction in agriculture as a chemical laboratory. The first floor of the agricultural high school at Berlin contains a museum in which are found the best types of agricultural implements of the United States, England, and Germany. The student who makes proper use of that museum has a better understanding of the principles which govern the construction of the tools he is to use and the modifications to conform to different uses than it would be possible for him to acquire in any other way, and it is a kind of training especially demanded by the conditions of American farm life.

This training in the agricultural institutions of Germany is regarded there as of the highest value not only by farmers but also by manufacturers. It gives them trained workmen in their shops and trained agents to extend their export trade in different countries. The union of agricultural and mechanical knowledge in their employees and agents has enabled German implement makers to greatly increase their export trade, and it is believed that the same result would follow similar training here. If we are to maintain our standing as a producing and manufacturing nation, we must maintain our superiority as designers and users of farm machinery, and this can be best promoted by bringing the intelligence of the trained experts of the Department of Agriculture and of the professors and students of our agricultural colleges to bear on this problem.

Of late, interest in the problems of rural engineering has been awakened in many agricultural regions in this country. A few colleges have created departments for instruction in certain branches of rural engineering, the departments of irrigation engineering in Colorado and California being illustrations of this, and a number of colleges are now beginning the establishment of courses in rural engineering with farm mechanics as the leading feature, and there is much interest in the development of these courses as independent lines of work. Among these are the colleges of agriculture in Illinois, Wisconsin, Minnesota, Iowa, and North Dakota.

The colleges attempting to establish courses in farm mechanics and other lines of agricultural engineering are immediately made aware of the fact that the data for the scientific and pedagogical basis of such courses are very meager, and they are, therefore, looking to this Department to aid them in instituting investigations to supply this information. Inquiries which might profitably be undertaken under this head include:

(1) Preliminary work in the collection and publication of information regarding the evolution, character, and uses of farm implements and machinery in this and other countries. This is important, because the available literature on the subject is scattered, fragmentary, and out of date. A small beginning has just been made in this direction in a bulletin on The Evolution of Reaping Machines, recently published by this Office, and another bulletin describing corn-harvesting machinery, which is being prepared.

(2) Laboratory and practical tests, involving a study of principles of construction and methods of operation of farm implements and machinery with special reference to efficiency and economy. These might very properly include certain strictly technical inquiries regarding the fundamental nature of the various mechanical farm operations with a view of suggesting the best means of performing them with the implements and machines at present available, or with others, the construction of which will be indicated by the results of the inquiries.

As an illustration of the usefulness of such work, the numerous tests which the experiment stations have already made of separators and other dairy apparatus may be cited. These tests have in general been so conducted as to bring out the relative effectiveness of different kinds of dairy apparatus without improperly advertising the merits of particular machines, and in this way both the dairymen and the manufacturers have been benefited.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

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Sections.

Section on college work and administration: W. E. STONE, of Indiana, chairman; G. E. FELLOWS, of Maine, secretary. Committee on programme: W. E. STONE, of Indiana; G. E. FELLOWS, of Maine, and H. W. TYLER, of Massachusetts.

Section on experiment station work: E. H. JENKINS, of Connecticut, chairman; M. A. SCOVELL, of Kentucky, secretary. Committee on programme: J. H. SHEPPERD, of North Dakota; B. W. KILGORE, of North Carolina, and M. A. SCOVELL, of Kentucky.

SEVENTEENTH ANNUAL CONVENTION.

The seventeenth annual convention of this association, held in Washington, November 17-19, 1903, was one of the largest meetings in point of attendance which has ever been held. Over 200 delegates and visitors were registered, and the representation was very general from different sections of the country.

President J. K. Patterson, of Kentucky, presided at the general sessions and delivered the annual presidential address. This dealt with the general topic of the origin and work of the colleges and

universities represented by the association and the influence of these institutions upon the development of technical and industrial education. It was an eloquent and scholarly review of the conditions in English and American history which have led up to the newer education, the influences which have had to be met and overcome in its development, and the recognition which technical education is now receiving, due in no small degree to the influence of the land-grant colleges of this country. A high tribute was paid to the great work of these institutions, which the speaker declared have given a new conception of manual training and set the pace for scientific study and experimentation in America. The application of their work he pronounced far in excess of the original conception, and their experience and the methods which they have worked out have served as an example to other countries. The speaker pictured the future of this country and the future development and position of the land-grant colleges, which he thought would occupy an increasingly prominent and important part in promoting industrial development and in contributing to the advancement of both general and applied science.

Pursuant to a resolution adopted by the association last year, provision was made for memorial addresses on the late President W. L. Broun, of Alabama, and the late President W. M. Beardshear, of Iowa. An address on the public life and services of Doctor Broun was delivered by President P. H. Mell, of South Carolina. Doctor Gunsaulus, of Chicago, who was to have delivered the address on President Beardshear, was prevented from being present, but he was requested to furnish the manuscript of his address for publication.

One of the most important items of business was the consideration of the amendments to the constitution proposed at the Atlanta meeting. These amendments had been before the association for a year, and were adopted with practically no discussion. They provide for a reduction in the number of sections to two, one on college work and administration and the other on experiment station work, three members of the executive committee to be chosen by the first section and two by the latter. No action on public and administrative questions is to be final without the assent of the college section. There is provision for each section to create such divisions as it may find desirable, but no such divisions have yet been made, and the report of the committee on the organization of the new section for station work recommended that for the present no such divisions be made. The section on horticulture and botany, however, expressed a desire to continue its meetings in the future, and appointed a committee to confer with the executive committee with reference to this matter.

A standing committee on programme was provided for by each of the new sections to which subjects for discussion may be suggested.

The executive committee, in its report, read by H. C. White, chair-

man, noted the efforts of the committee to secure the consideration of the mining school bill and the steps which have been taken toward making a campaign for an increase in the Federal appropriation for experiment stations. It was successful in securing an appropriation for a college and station exhibit at the St. Louis Exposition, and has ascertained that the agricultural colleges will not be discriminated against in distributing the benefits of the Cecil Rhodes bequest. The committee was directed by resolution to continue its effort to secure the passage of the mining school bill and an increase in the appropriation for the experiment stations. On recommendation of the committee it was voted that hereafter vacancies in standing committees, caused by resignation or death, may be filled by the respective committees.

The report of the treasurer, E. B. Voorhees, showed the total receipts during the year to be \$1,688.55, and the total expenditures \$1,425.29, leaving a balance in the treasury of \$263.23. It was voted to continue the annual assessment at \$15. The report of the bibliographer, A. C. True, called attention to the more important bibliographies which have appeared during the year, a list of 110 bibliographies, with explanatory notes, constituting the main part of the report. Special mention was made of the International Catalogue of Scientific Literature. The incompleteness of this catalogue in regard to certain lines of work in agricultural science, notably the work of the experiment stations, was a matter of much regret.

The standing committee on indexing agricultural literature called attention in its report to the index cards for the publications of the Department of Agriculture which are being prepared by the library, and also to the cards for the accessions to the Department library. The latter are now being printed by the Library of Congress, and can be obtained at small cost, as may also the catalogue cards for the Library of Congress relating to agriculture. The card catalogue of the Department library now contains over 110,000 cards, and the library is thus in position to render more efficient aid than ever before to the agricultural colleges and experiment stations by furnishing them information in regard to the literature on particular topics, loaning books, etc. Attention was called in this report to the combined index, now in press, of the first twelve volumes of Experiment Station Record, and to the card index of agricultural literature issued by this Office. By request of the association this report has been published as Circular No. 54 of this Office.

The report of the committee on methods of teaching agriculture, presented by A. C. True, was on the relation of the natural sciences to agriculture in a four years' course, and presented a plan for a course of study including these natural sciences, together with brief mention of the principal subjects to be covered under each. The report pointed out that the older method of arranging the courses in agriculture tended to make specialists in such subjects as agricultural chemistry,

or vegetable pathology, rather than to make trained agriculturists. It was urged that there should be a sufficient period of general study before specialties are taken up, and that the paths of the specialist and the agriculturist should early diverge. The college course can not be expected to fit men for expert work in this Department, the experiment stations, and similar institutions, but for such work, at least, the master's degree, and ere long the doctor's degree will likely be required. This paper brought out much discussion, illustrating the marked interest which has developed within the past few years in the matter of courses of study and in agricultural education of different grades.

There was considerable discussion of the subject of the graduate school of agriculture, and the hope was expressed that it may be possible to arrange for a session of this school next summer. This matter was placed in the hands of the committee on graduate study at Washington, whose title was changed to the committee on graduate study. President Northrop withdrew from this committee, owing to his inability to satisfactorily look after its interests, and President C. W. Dabney was appointed chairman in his place, the vacancy on the committee being filled by the appointment of L. H. Bailey.

The report of the standing committee on military instruction in land-grant colleges was made by G. W. Atherton. The committee reported interviewing the officials of the War Department and receiving from them an unfavorable report relative to any change being made in General Orders 94, which increases the amount of military instruction in the colleges and reduces the detail of officers to two years. This order was characterized by the chairman and by other speakers as impossible of execution, and called forth a vigorous discussion, which resulted in the adoption of a resolution requesting the committee on military instruction to continue its efforts to secure a modification of General Orders 94 and to formulate a practicable scheme for military instruction at the colleges.

The standing committee on agricultural engineering presented its first report through W. E. Stone, chairman. The report pointed out the increase in the number of engineering problems in agriculture and their prominence, the enormous extent to which agricultural machinery is being used by American farmers, the problems of irrigation and of drainage, the terracing of hillsides, the construction of roads, and other matters, as illustrating the desirability of more systematic attention to instruction in these topics in connection with the college courses and of extended scientific investigation. The committee declared in favor of separate departments of rural engineering in the colleges, and the enlargement of the work of this Department to include agricultural engineering in addition to irrigation, and recommended that the executive committee of the association aid in securing the increased appropriation asked from Congress for the latter purpose. This report was adopted, and the association also

adopted a resolution commending the work of the Department along the lines of irrigation and agricultural engineering. A special request was made that the report of the committee be speedily published in circular form, and it has been issued as Circular No. 53 of this Office.

The report of the committee on collective college and station exhibit at the St. Louis Exposition was presented by W. H. Jordan, chairman, who outlined the origin and history of this movement, and gave an abstract of the law making appropriation for the exhibit, details concerning the exhibit, and a list of the persons in charge of the different exhibits.

The report of the committee on cooperation between the stations and this Department, presented by E. A. Bryan, called attention to the statement of fundamental principles embodied in the two previous reports, expressed gratification at the appointment of a committee within the Department of Agriculture for perfecting the details of a system of cooperation, and reiterated its belief that a full and free consultation between the stations and the members of the Department forces in regard to the work undertaken in the several States is very desirable and would do much to remove possible sources of friction.

The standing committee on uniform fertilizer laws, of which H. J. Wheeler is chairman, called attention to the satisfactory progress which is being made in the direction of greater uniformity, the recommendations of the association having been of value in securing the recent passage or amendment of fertilizer laws in Alabama, Florida, Indiana, Missouri, North Dakota, Pennsylvania, and Tennessee. This report also included recommendations concerning the provisions of laws for feeding-stuff inspection.

The report of the standing committee on pure-food legislation, made by W. A. Withers, noted considerable progress along the line of pure-food legislation during the year. New legislation was enacted in two States, and provisions made by Congress for the inspection and control by this Department of foods imported from foreign countries. This was pronounced an unusually important step in food legislation, and its execution has resulted in considerable progress in the preparation of standards of purity.

The report of the standing committee on animal and plant breeding was presented by the chairman, W. M. Hays, who reported progress and announced a meeting to be held at St. Louis, December 29 and 30, 1903, for the purpose of forming an association of plant and animal breeders.

The committee on revision of methods of seed testing recommended certain changes in the previous report, published as Circular 34 of this Office. These changes relate to an improved germinating chamber and other apparatus, instructions for sampling, etc.

The farmers' institute work, which the Department has taken up through this Office, was outlined by A. C. True, who stated clearly the policy of the Department in regard to this work. There will be no attempt to interfere with the State management of farmers' institutes in any way, but rather to cooperate with the State officials and to aid them in building up the institutes in the several States. The Department will be a general agency for coordinating and strengthening this work throughout the country. One of the main objects at present is to help to increase the efficiency of the institute lecturers, now numbering over 800, less than half of whom are connected with the work of the colleges or the stations. A corps of specially trained institute workers was recommended as eventually desirable, to relieve the college and station men of much of the burden of this work, as it is still the opinion of the Office that the prime object of college men is to teach and of the station men to investigate.

A resolution presented by C. E. Thorne commended the reviews furnished by the Experiment Station Record, and suggested an extension of these to include more full abstracts in the case of some of the foreign publications, which are accessible to only a portion of the station workers, and directed the executive committee of the association to urge upon the Secretary of Agriculture the securing of additional funds for this purpose.

The plans of the new building for the Department of Agriculture were exhibited and explained by B. T. Galloway.

The three sessions of the section on agriculture and chemistry were occupied chiefly with papers and discussions relating to soils, especially soil fertility. Throughout these discussions there were frequent references to the principles laid down in Bulletin 22 of the Bureau of Soils, and their conflict with views which have previously been held regarding soil fertility and maintenance. The papers presented included *The Present Status of Soil Investigations*, by C. G. Hopkins; *The Chemistry of Soils as Related to Crop Production*, by E. W. Hilgard; two papers on *Methods of Conducting Investigations Relating to Maintenance or Increase of Soil Fertility*, by C. E. Thorne and E. B. Voorhees; and a discussion of the same subject by H. W. Wiley; *Differences between four Southern and four Northern Soils*, and *Improvements in Soil Management which these Differences Suggest*, by F. H. King; *Methods for the Extension and Practical Application of Soil Surveys*, by R. H. Forbes; *Methods and Value of Securing Irrigation Supplemental to Rainfall for Humid and Semiarid Districts*, by L. G. Carpenter; two papers on *Experiments in Animal Breeding*, by F. B. Mumford and C. S. Plumb. There was also a discussion of *Methods for the Extension and Practical Application of Soil Surveys*, by Milton Whitney.

The topic of Botany and Horticulture was the main theme of a dis-

cussion in the section on horticulture and botany. A. F. Woods presented, for the committee on courses in botany, an outline of a course in elementary botany, together with suggestions as to more advanced courses. Botany in the Agricultural Course, was the subject of a paper by L. H. Pammel; The Foundation of Agricultural Teaching, by H. Metcalf; and, Methods of Practical Instruction in Horticulture, by H. L. Hutt. Other topics discussed were, Desert Botanical Laboratory, by F. V. Coville; Cooperation and the Granville Tobacco Wilt, by F. L. Stevens; and Crop Rotation as a Factor in Combating Plant Diseases, by W. A. Orton. The committee on plant-breeding nomenclature reported in favor of the use of the word "elon" which has lately been proposed by H. J. Webber for plants grown from cuttings, bulbs, etc., the progeny all being members of the same individual.

In the section on entomology a number of interesting and instructive papers were read, including the following: Problems of Forest Entomology, by A. D. Hopkins; Keeping Entomological Notes, by C. M. Weed; The Necessity of Uniform Methods of Inspection of Nursery Stock, by A. J. Burgess; The New Jersey Ideal in the Study and Report upon Injurious Insects, by J. B. Smith. The latter argued that the farmers desired practical information and did not care for technical details. The entomological bulletins should be educational, but should not contain material relating to synonymy, or even descriptions of new species. The feeding habits of insects should be described, likewise the nature of injury caused by them and the reason for the application of the recommended treatment. Attention should also be called to the relation of the treatment of agricultural methods and the life history of the insects.

The attention of the section on college work was given to two subjects: The Mission of the Land-Grant Colleges, and Short Courses. The first subject was introduced by W. O. Thompson, of Ohio, in a paper setting forth (1) the history of the movement bringing the land-grant colleges into existence, and (2) the writer's interpretation of the first and second Morrill acts, based partly on the discussions in Congress bearing on those acts. Briefly stated, the writer's conclusions were that those favoring the establishment of the land-grant colleges were of the opinion that some other form of education than the classical may be liberal; that it was the intention of these men to give a liberal as well as a practical education, implying that industrial education is liberal; that precedence was to be given always to agriculture and the mechanic arts, and that military instruction was intended to occupy a subordinate position.

A round-table discussion of short courses was participated in by nearly a dozen speakers, who presented the various conceptions of the scope and function of the short courses in the agricultural college.

THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

OFFICERS.

President,

B. W. KILGORE, of North Carolina.

Vice-President,

E. E. KAUFMAN, of North Dakota.

Secretary-Treasurer,

G. C. CREELMAN, of Toronto, Canada.

Executive Committee,

GEO. MCKERROW, of Wisconsin.

H. G. EASTERLY, of Illinois.

J. C. HARDY, of Mississippi.

Ex-officio: The PRESIDENT and the SECRETARY-TREASURER.

EIGHTH ANNUAL MEETING.

The eighth annual meeting of the American Association of Farmers' Institute Workers was held in the Parliament Buildings, Toronto, Canada, June 23-26, 1903. Seventeen of the States of the Union and four of the Provinces of the Dominion of Canada were represented by their institute officials.

The association was welcomed to Canada by the Hon. G. W. Ross, premier of Ontario, who spoke of the remarkable progress which agriculture had made in recent years, both in the United States and in the Dominion of Canada, and of the friendly competition that exists between the two countries.

The president, W. C. Latta, in his annual address, reviewed the scope and growing importance of the farmers' institute work, dealing particularly with the means of making it more effective for good. Referring to the training of the institute worker, he said that this should be special and "should include a boyhood spent on the farm, a common and high school education, a thorough technical training at an agricultural college, and, after graduation, several years of experience in some line of practical agriculture." The qualifications of the workers and the organization of farmers' institutes were discussed at length.

The programme included the following papers, most of which were quite freely discussed: Training for Institute Work; Prime Qualifications; Should the Worker have Special Training? How may it be

Secured? Franklin Dye, Trenton, N. J. Organization for Institute Work—Should it be a Permanent Organization or should we work through other Farmers' Organizations? L. R. Taft, Agricultural College, Michigan. Accessories in Institute Work—Demonstrations, Judging Contests, Field Experiments, F. H. Rankin, Urbana, Ill. How far is it Practicable to Conduct a Season's Campaign in some Agricultural Interest? What Interests may be Appropriately and Successfully Advanced, such as Roads, Homes, Reforesting, Agriculture in High Schools, or Agricultural Education? F. E. Dawley, Fayetteville, N. Y. How to Advertise Institute Meetings, Geo. McKerrow, Madison, Wis. The Evening Session—How to make it Interesting and Instructive: (a) The Romance of Agriculture, C. C. James, Toronto, Canada; and (b) Local Help, Wesley Webb, Dover, Del. Some Essentials to the Permanency of Farmers' Institutes, E. B. Voorhees, New Brunswick, N. J. How the Farmers' Institutes and the Agricultural Colleges may be mutually helped, Dr. James Mills, Guelph, Canada. How the National Department of Agriculture may through its Institute Office assist the State Institute Meetings, John Hamilton, Washington, D. C. Women's Institutes, Miss Laura Rose, Guelph, Canada, and Miss Agnes Smith, Hamilton, Canada. How the Institutes can Bring the Most Good to Our Girls, Miss Blanche Maddock, Guelph, Canada. How to Enlist the Interest of Our Boys in Agriculture, Hon. John Dryden, Toronto, Canada.

There was a discussion of problems and methods in institute work, participated in by delegates selected from different sections of the country; and the institute work from the standpoint of the worker was discussed by D. C. Anderson, Andrew Elliott, and Henry Glendinning, of Ontario.

The reports of the directors giving account of the institute work in the several States all indicated that progress had been made during the year, and that appreciation of the work is becoming more general as the public becomes better acquainted with what is being done for the benefit of agriculture through this method of instruction and with what is possible to be accomplished.

Expressions with regard to the quality of the work required showed that the people were not satisfied with anything but the best. The problem now confronting the institute directors is that of securing a sufficient number of capable instructors to meet this need. Two of the State directors reported that they were about to introduce into their system a normal school plan for training lecturers, the instructors in these schools to be selected from the forces of the agricultural college and experiment station and the school to continue from one or two or three weeks, as the necessities in each case seem to justify.

On Thursday the members of the association and their friends were given a complimentary trip to the Ontario Agricultural College, at

Guelph, where luncheon was served and visitors were escorted over the grounds and through the buildings by the members of the faculty. The president, Dr. James Mills, explained to the association the work and purpose of the college.

At a business meeting on Wednesday several amendments to the constitution, proposed at the last annual meeting, were considered and adopted. Among them was one providing for representation of this Department in the association by two delegates, one from the Department at large and one from the Office of Experiment Stations. Resolutions were passed expressing appreciation of the interest manifested by the Department and the Office in the institute work and in the meetings of the association, and approving the step which has been taken in establishing an agency in the Department for its promotion and aid.

St. Louis was selected as the place of the next meeting, the date being left for the executive committee to fix.

OFFICE OF EXPERIMENT STATIONS.

GENERAL OUTLOOK.

The business of the Office of Experiment Stations has continued to grow during the past year, and several new features have been especially developed. The work in relation to the farmers' institutes has been put on a permanent basis, and systematic efforts are now being made to bring the Department into close relations with the State organizations through which the institutes are managed. Attendance at the institutes now aggregates about 1,000,000 persons. It is believed that they may be made a very effective means for the more thorough dissemination of the information gathered by this Department and the experiment stations. There has been increased interest in the work of the Office relating to agricultural education. During the past year special emphasis has been placed on encouraging the establishment of secondary and elementary courses in agriculture. The agricultural experiment stations in Hawaii and Porto Rico have made good progress in the institution of systematic investigations, and gratifying recognition of the value of the work of these stations has been made by the insular governments, as indicated by liberal appropriations for their equipment and the extension of their work. In Alaska a beginning has been made of investigations in the Copper River Valley, where there is a large region suited to agriculture, and it is hoped that means may be provided for the establishment of a permanent station in this region. In the irrigation investigations greater attention has been given to studies of the duty of water in different regions and for various crops, with a view of determining how the water supply of the irrigated region may be most economically and efficiently used. Attention has also been given to the legal and economic problems involved in the use of interstate streams for irrigation. Special efforts are being made to enlarge the work of the Office in the investigation of problems relating to farm machinery and the use of different kinds of power for agricultural purposes. It is believed that the investigations in this line might be extended with great advantage to the agriculture of the country. Their results would also aid the agricultural colleges to put on an efficient basis the courses in farm mechanics, for which there is now a great demand and which some of these institutions are already establishing. A new feature of the nutrition investigations has been a large cooperative investigation in

the Government Hospital for the Insane in the District of Columbia, which has resulted in showing that, while the diet given the patients and employees in that institution was ample as regards its nutritive value, greater variety might be afforded, and at the same time much waste might be avoided, by stricter supervision of the food supply as related to its nutritive value. Important investigations on the digestibility of cereals, fruits, and meat were completed, and reports on a large series of metabolism experiments with the respiration calorimeter were prepared for publication. In cooperation with the Association of American Agricultural Colleges and Experiment Stations, the Office has undertaken a large amount of work in connection with an exhibit of the progress of agricultural education and research at the St. Louis Exposition.

LINES OF WORK.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of the stations; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, and Porto Rico; special investigations on the nutrition of man and on irrigation, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories. A new feature of the work of the Office has been the systematic promotion of the interests of the farmers' institutes throughout the United States.

INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general business of the Office.....	\$37, 000
For the Alaska Experiment Stations	15, 000
For the Hawaii Experiment Station	12, 000
For the Porto Rico Experiment Station.....	12, 000
For nutrition investigations.....	20, 000
For irrigation investigations	65, 000
Total	161, 000

PUBLICATIONS.

During the year the Office published 44 documents, aggregating 4,112 pages, a substantial increase over the output of the previous year. The publications issued include 13 numbers of the Experiment Station Record, 14 technical bulletins, 2 bulletins of the Porto Rico

Experiment Station (English and Spanish editions), 2 reports, 4 Farmers' Bulletins (including 2 numbers of the subseries Experiment Station Work), 3 circulars, and 4 articles for the Yearbook of the Department. Two other numbers of the Experiment Station Record and 7 bulletins, containing 1,027 pages, were prepared and submitted for publication during the year. The policy of reprinting separates of individual articles contained in larger reports has been continued with the same satisfactory results as heretofore. Eighty-one such separates, aggregating 2,074 pages, have been reprinted in editions of varying size to meet the actual demand for the articles. Several documents formerly printed separately by Congress were combined in the Annual Report of the Office of Experiment Stations, as was done last year.

Experiment Station Record, Vol. XIV, pp. 1267.—This contains abstracts of 377 bulletins and 52 reports of the experiment stations in the United States, 176 publications of the Department of Agriculture, and numerous reports of foreign investigations. The total number of abstracts is 4,620, classified as follows: Chemistry, 230; botany, 177; fermentation and bacteriology, 49; zoology, 51; meteorology and climatology, 102; air, water, and soils, 183; fertilizers, 184; field crops, 344; horticulture, 463; forestry, 199; seeds and weeds, 73; diseases of plants, 371; entomology, 371; foods and nutrition, 257; animal production, 344; dairy farming and dairying, 208; veterinary science and practice, 670; technology, 27; agricultural engineering, 158; statistics and miscellaneous, 159.

This volume contains condensed accounts of the convention of the Association of Official Agricultural Chemists, 1902; International Conference on Plant Breeding and Hybridization, convention of the Association of American Agricultural Colleges and Experiment Stations, and the meeting of the American Association for the Advancement of Science as regards agricultural science; a description of the new buildings at the New Hampshire and Missouri agricultural colleges, and an article on Values in Science, by W. H. Jordan. The following topics are discussed in the editorials: Increased funds for station maintenance; education of the American farmer; Royal Society's catalogue of scientific papers; fiftieth anniversary of the first State experiment station; Prof. A. Petermann, founder of the experiment station system of Belgium; Jacob Richards Dodge, agricultural statistician; Virchow's service to agriculture, progress in plant breeding; Dr. Robert C. Kedzie, a pioneer in agricultural science; new yearbook of the Russian experiment stations; overworking among experiment station men; need of extending the scope of station operations; some factors in research work; P. P. Deherain, deceased; agricultural experimentation in the Philippine Islands; the agricultural appropriation act, 1903-4; the Department publications; the soil survey in 1903; school garden at the Department of Agriculture; need of experiments with horses; an index

catalogue for agricultural libraries; an index of scientific periodicals; memoir of the National Institute of Agriculture at Paris; progress of secondary education in agriculture; the exhibit of the land-grant colleges and agricultural experiment stations at St. Louis, and conclusion of Vol. XIV.

The largest undertaking connected with the Record has been the completion of the general index to the first twelve volumes. This work, which has been in progress for some two years, has proved far more time-consuming and laborious than could be anticipated. It covers the two parts of Experiment Station Bulletin No. 2, which contain the abstracts of the reports of the experiment stations for 1888, the first year after their organization under the Hatch Act, as well as Volumes I to XII of the Experiment Station Record. It therefore begins with the work of the experiment stations under the Hatch Act and covers the period down to the close of the century (the year 1900). The indexes to this work are contained in fourteen different volumes, many of them large and cumbersome to handle. In combining these indexes the entries have been systematized and extended, and every effort has been made to make the references complete under appropriate headings and easily found by means of cross references. In its completed form the index contains about 125,000 entries, and is undoubtedly the most extensive index to the literature of agricultural experimentation which has ever been issued.

Miscellaneous technical publications.—These included a Digest of Recent Experiments on Horse Feeding; Progress in Secondary Education in Agriculture; Some Practical Results of Experiment Station Work; Proceedings of the Fifteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations; Proceedings of the Seventh Annual Meeting of the American Association of Farmers' Institute Workers; Organization Lists of the Agricultural Colleges and Experiment Stations in the United States; Statistics of the Land-grant Colleges and Agricultural Experiment Stations in the United States; and publications on nutrition and irrigation, noted on pages 68 and 76, respectively.

Farmers' bulletins.—These included articles on Silos and Silage, Principles of Horse Feeding, and two numbers of Experiment Station Work.

Card index.—Copy for 1,700 cards of the index of experiment station literature was prepared during the past year, and the number of index cards distributed reached 23,000.

AGRICULTURAL EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

Agricultural experiment stations were regularly maintained during the past year, as heretofore, at Sitka and Kenai, and a new station was established at Copper Center, Alaska. The Hawaii Experiment Sta-

tion, located at Honolulu, developed its work along a number of useful lines. The Porto Rico Station, the headquarters of which were removed to Mayaguez, has been more fully organized, and its work has been established on a permanent basis. For accounts of the work of these stations see pages 81, 103, and 174.

NUTRITION INVESTIGATIONS.

During the fiscal year ended June 30, 1903, the inquiry regarding the food and nutrition of man, conducted under the auspices of this Office, has been continued along the same general lines as hitherto. This work, as heretofore, has been in charge of Prof. W. O. Atwater. There was no increase in the appropriation granted by Congress (\$20,000), and it has been impracticable to extend the work in some directions, as was desired; but for the amount expended large results have been obtained.

As in former years, a considerable portion of the amount appropriated has been divided among various educational, scientific, and similar institutions throughout the United States, the sum allotted serving more as an encouragement to research than as actual compensation for the work done. These cooperating institutions have thus been made centers of scientific research in this particular line of investigation and have in most cases contributed largely in laboratories, apparatus, libraries, the counsel and assistance of experts, and similar gratuitous service. By this method of cooperation the amount appropriated has been expended more economically and yielded larger returns, a greater variety of questions has been studied under different local conditions, a more widespread interest in the investigations has been aroused, a corps of skilled investigators throughout the country has been trained for the carrying out of such inquiry, and the results obtained have been made more extensively available.

The nutrition investigations are devoted mainly to the study of the physiological, hygienic, and economic branches of the subject. The chemical work is confined chiefly to determinations of the composition of different food materials and excretory products involved in the experimental inquiries, and is only preliminary to the study of the physiological branch of the subject, the principal object of the inquiry being to discover the fundamental laws of nutrition and their economic and sociological application to the food of man.

To this end four general classes of investigations have been carried out: (1) Dietary studies; (2) digestion experiments; (3) cooking experiments, and (4) metabolism experiments.

The dietary studies have been made in several widely different localities and have included the study of the diet of people varying in occupation, age, sex, and circumstances. Their purpose has been to procure data in regard to the kinds, amounts, and costs of food

materials under different conditions, to give opportunity for comparison with the data obtained by investigators in other countries, and to assist in establishing a general dietary standard.

The digestion experiments have also been carried on in different parts of the United States under varying conditions. These experiments have been made in order to obtain data with reference to the digestibility of various classes of food materials, the amount of the material consumed which is made available to the body, and the establishment of standards. Meats, legumes, cereals, fruits, and nuts have been the especial subjects of experiments the past year. The digestion experiments with meat have included the study of the influence of cooking, as well as of age and breed of animal, etc., upon the digestibility. The digestion experiments with cereals have included the study of the effect of different methods of the milling of flour upon the digestibility of bread made from it.

The cooking experiments have been made only with meat, and have included the study of the effects of cooking upon the flavor, palatability, and digestibility of the meat, beef being usually used for the purpose.

The metabolism experiments have been of two general sorts: (1) Those in which the income and outgo of nitrogen were studied, and (2) those which took account of the income and outgo of nitrogen, carbon, and energy. The former have been made in connection with all the digestion experiments. The latter have been made only at Middletown, Conn., as they necessitate the use of the respiration calorimeter.

In connection with all investigations some analytical work, both physical and chemical, was, of course, necessary for the successful carrying out of the experiments. The development of apparatus and methods has received much attention the past year, especially at Middletown. A large amount of editorial work, including calculations and the verification of data, has also been required at both Washington and Middletown to prepare the results of the investigations for publication in both technical and popular form.

THE WORK AT DIFFERENT PLACES.

The Washington office, in addition to editorial work, has had general supervision of the plans and expenditures of the nutrition investigations during the past year. The results of such inquiry in this country and in Europe, not generally available, and bibliographical data, have been collected, and the current literature on the subject of nutrition has been reviewed and abstracts made, partly for use in the Experiment Station Record and partly for such other purposes in connection with the general inquiry as seemed desirable.

In cooperation with the Department of the Interior, some very interesting dietary studies have been carried on in the Government

Hospital for the Insane, Washington, D. C. These investigations were inaugurated at the desire of the late Dr. A. B. Richardson, superintendent of the Government hospital, as a part of his general plan for maintaining a high standard for the conditions under which the patients and employees lived in this great institution. By reason of his intelligent appreciation of the requirements of such work satisfactory arrangements were made for its prosecution. The studies were under the direct charge of H. A. Pratt, who had previously assisted in such investigations at the Elmira Reformatory, Elmira, N. Y., and elsewhere in connection with similar studies made under Professor Atwater's direction.

Twenty-seven dietary studies were made in all, with about 1,600 male patients and 125 employees. The results of these studies have been edited and are nearly ready for publication. Investigation has shown that in general the food of the Government hospital is wholesome in quality and adequate in amount. In many cases it was found that the waste was excessive. Steps were immediately taken to check the waste, and as a result the cost of the food for the year was considerably lowered without affecting in any way the quality or amount. A consideration of the details of the studies suggests numerous ways in which the results can be further applied.

The work at Middletown, Conn., under Prof. W. O. Atwater, chief of the nutrition investigations, has included the planning and direct supervision of the cooperative investigations throughout the country; improvements in apparatus and methods; the carrying out of special inquiries with the bomb and respiration calorimeters; such analytical work as was necessary in connection with the investigations; editorial work in preparing the results of the inquiries for publication; the compilation of results of investigation in this and other countries on the food and nutrition of man; correspondence and general administrative work.

The work with the respiration calorimeter, which is under the more immediate supervision of Prof. F. G. Benedict, has been largely devoted to the modification and improvement of the apparatus, with such experimental work as was required to test its accuracy. In its modified form, the ventilation air current is in a "closed circuit," that is, the same air is used over and over again. The water and carbon dioxid imparted to the air by the subject are constantly removed by passing the current through sulphuric acid and through soda lime; oxygen is then added to replace that used by the man under experiment. This arrangement permits the more accurate determination of carbon dioxid and water and, a still more important feature, the direct determination of oxygen, which has been made possible by the changes in the apparatus made under a grant from the Carnegie Institution.

The nutrition investigations at the University of California, conducted by Prof. M. E. Jaffa and his associates, were a continuation and completion of the work begun in 1901-2, which has comprised 30 digestion experiments, including the income and outgo of nitrogen, with subjects whose food consisted of fruits and nuts only or largely, as well as seven dietary studies with fruitarians, and a number of analyses of samples of food materials and excretory products.

Professor Jaffa has also written a complete report of the two years' work, at the same time compiling and collating much useful material on the nutritive value of fruits and nuts to round out his report and make it more complete. The result forms a publication of much interest, particularly in view of the fact that hitherto comparatively little attention has been paid to this subject, which is of especial importance to the people of California, fruits and nuts forming so large a part of the agricultural products of the State.

The nutrition investigations at the University of Georgia, under the direction of President H. C. White, included the study of the dietaries of typical families of white people of limited means in the mountain districts of the State, and one dietary study of a negro laborer's family. In all 10 dietary studies were made and 55 analyses of food materials and wastes. The results obtained show a very simple diet. The articles of food are few and the methods of preparation primitive.

Prof. H. S. Grindley has continued his valuable work with meats at the University of Illinois the past year. This included the carrying out of 20 digestion and nitrogen metabolism experiments with men, in which meat (beef) formed the chief part of the diet; 65 artificial digestion experiments with different kinds of meat to determine the influence of cooking upon the digestibility; 47 cooking experiments with meats to determine the losses in cooking and its influence upon flavor, palatability, digestibility, etc. In addition to his experimental work, Professor Grindley has prepared a bulletin on the cooking of meats, which gives the results of his investigations in this direction.

The chief studies undertaken at the University of Maine, under the direction of Prof. C. D. Woods, were those carried out in logging camps, with men doing large amounts of muscular work under severe conditions of cold and exposure. Six digestion experiments of six days each with wood choppers were made with the analysis of the food materials and excretory products. Two dietary studies were also conducted with crews in logging camps, analyses being made of the foods used. The dietary studies showed that the lumbermen who performed very large amounts of work ate correspondingly large amounts, the diet being high in both protein and energy.

At the University of Minnesota, Prof. Harry Snyder has continued his investigations regarding the nutritive value of flour milled in dif-

ferent ways when made into bread. The inquiry has been especially satisfactory this year, as the experimental mill of laboratory size, purchased last year, has made it possible to secure uniform grades of flour for use in the investigations.

Prof. C. E. Wait, at the University of Tennessee, Knoxville, has continued his investigations along the same lines as heretofore, two kinds of work being undertaken, namely, dietary studies with white people of limited means in the mountain districts, and digestion experiments for the purpose of studying the digestibility of legumes. In connection with the latter, the income and outgo of nitrogen has been determined. The dietary studies have been carried out under unfavorable conditions, but the results are of especial interest.

FOOD AND NUTRITION PUBLICATIONS.

The food and nutrition publications the past year have included six technical bulletins, an article for the Yearbook of 1902, and an article prepared for the report of this Office for the same year. The subjects treated in these publications are as follows:

Dietary Studies in New York City in 1896 and 1897; Experiments on the Effect of Muscular Work upon the Digestibility of Food and Metabolism of Nitrogen; Experiments on the Metabolism of Nitrogen, Sulphur, and Phosphorus in the Human Organism; Studies on the Digestibility and Nutritive Value of Bread at the University of Minnesota in 1900-1902; Dietary Studies in Boston and Springfield, Mass., Philadelphia, Pa., and Chicago, Ill.; Further Investigations among Fruitarians at the California Agricultural Experiment Station; Dietary Studies of Groups, especially in Public Institutions; the Cost of Food as Related to its Nutritive Value.

IRRIGATION INVESTIGATIONS.

The irrigation investigations of this Office have been carried on during the past year under the general direction of Prof. Elwood Mead, who, in addition to the general oversight of the work, spent two months in Italy making a special study into the irrigation laws and practice of that country. A field office is maintained at Cheyenne, Wyo., for the Rocky Mountain States, and one for California at Berkeley. During the year C. T. Johnston, assistant chief of these investigations, resigned to accept the position of State engineer of Wyoming, and C. E. Tait was placed in charge of the Cheyenne office. Prof. S. Fortier has charge of the Berkeley office.

The only changes in the work from that of previous years were along the lines of greater thoroughness and more advanced investigations in the determination of the duty of water and in studies of the best means of distributing and applying it. It is believed that the investigations carried on during the year were in a field of urgent practical necessity

to the development of the agriculture of the arid and semiarid portions of this country, and were indispensable to the securing of the best use of land and water. The work in drainage was greatly extended during the year, and is destined to have great practical usefulness in reclaiming land now unproductive and in promoting the success of farming in many of the leading agricultural States.

The investigations authorized by Congress, of the use of various forms of power in farm work, which were assigned to this Office, deal with the feature of American agriculture which has given us our supremacy in the markets of the world. Other countries where this phase of agricultural engineering has not one-tenth the importance it has with us are carrying on comprehensive investigations in the care and use of farm machinery, and we can not wisely longer neglect them.

INVESTIGATIONS IN THE ARID REGION.

The distribution of the field work in the various arid States has been governed by those features of irrigation practice most needing to be improved and the places where they could be most effectively studied, the latter being influenced in part by natural conditions and in part by our cooperative arrangements made with the State experiment stations and the State engineers' offices. The following are the leading lines of work carried on in the different arid States:

- (1) Experiments to lessen the loss and damage from seepage.
- (2) Improvement of methods of distributing and applying water, so that the quantity now used on one acre will suffice for two.
- (3) Gathering more accurate information about cost and feasibility of pumping water for irrigation.
- (4) Improving methods of measuring water, and the organization of farmers for its more just and systematic division among them.
- (5) Surveys and investigations of districts needing drainage and giving advice to districts and communities regarding the legal and engineering problems of drainage.
- (6) Studies of the legal and social questions connected with the diversion and use of streams in irrigation.

The need of the exercise of economy and skill by irrigators in the use of the western water supply is becoming more and more manifest. The great extension of irrigation of citrus fruit in southern California has so increased the demand for water that the surface and underground supplies now available will meet present needs only through the employment of the best methods. As these orchards grow older more water will be needed and their growth and maintenance require that waste and loss of water be stopped as far as possible. Methods can not be perfected by the unaided individual irrigator. The questions involved are so complex as to require careful study by capable

and experienced men and a large expenditure of time and money. It is not simply a question of finding out suitable methods, but of working out the best detail and practice of those methods. It is one thing, for example, to determine that the check system of irrigation is the best for a particular locality, but it is quite another to determine the details of the checks, boxes, and laterals in order that the water applied to thousands of acres of land shall reach its surface with the least loss and waste from seepage and evaporation. The studies required involve not simply the various methods, but the comparative cost and efficiency of different patterns and different materials used in pipes, flumes, boxes, and other contrivances which must be used in carrying out these plans.

Closely associated with efficiency in applying water is efficiency in operating ditches. We are learning that certain soils are not suited to the carrying of water in earthen channels. The crossing of unlined canals over gravel beds or soils impregnated with gypsum is too wasteful of water, and is also too great a menace to the fertility of the lands affected by the escaping water, to be continued. The construction of irrigation canals will therefore soon have to be supplemented by other improvements in irrigation; either the lands below canals which leak will have to be drained or such canals will have to be lined to prevent excessive leakage. We are aiding communities in overcoming the injuries already wrought and in taking steps to prevent them in the future, by measuring the water which escapes by seepage, determining the places of excessive loss, and keeping records of the rise of water in the soil. Supplied with these facts, irrigators will be able to determine the location and sizes of drains needed to prevent the swamping of large areas. So urgent is the demand for the information gathered this year that we are issuing circulars giving the report of the past season's measurements in advance of the regular reports.

The conditions in the Yakima Valley, Washington, serve to illustrate the possible benefits to come from the perfection of systems of distribution. The report of Professor Waller, who has charge of our investigations in that State, shows that if a duty of 110 acres for each cubic foot of water per second can be secured the water of the Yakima River will serve to irrigate 300,000 acres of land, but if the low duty now prevailing under a number of canals is continued, not one-third of that area can be irrigated.

Cooperative arrangements for the conduct of these investigations have been made with the State engineers' offices and the State experiment stations in the following arid States and Territories: California, Oregon, Washington, Idaho, Montana, Nevada, Utah, Wyoming, and New Mexico; and in the following semiarid States: South Dakota, Nebraska, Kansas, and Texas.

The largest expenditure in any State is being made in California, the work being carried on under the direction of Prof. S. Fortier, until recently the director of the State experiment station of Montana. Associated with Professor Fortier in this work are Prof. J. N. LeConte, A. P. Stover, and J. F. Roadhouse, of the University of California. The field investigations in pumping are under the direction of A. J. Turner.

In Oregon the field investigations are being carried on by Prof. J. Withycombe, director of the Oregon Experiment Station.

In Washington, Prof. O. L. Waller, irrigation engineer of the State Agricultural College, at Pullman, has charge of the field work, and was assisted in 1903 by S. O. Jaynes. Professor Waller measured the water diverted from the Yakima River in order to determine the general duty obtained, the amount needed to satisfy the rights already acquired, and the amount available for future extension of irrigation along this stream. It is an important work and justifies a larger expenditure of funds than this Office has been able to provide. The lack of funds, however, was largely overcome by the energy and economy which distinguished the management of Professor Waller and his assistant.

The work in Idaho was under the direction of A. E. Wright, one of the assistants of this Office, who worked in cooperation with the State engineer's office in a study of seepage losses in the valleys of the Raft and Lost rivers.

In Montana the work was carried on under a cooperative agreement with the State experiment station, Prof. J. S. Baker of the station having personal charge. It included studies of the duty of water along a number of streams and the beginning of an investigation to determine the benefits of winter irrigation and the best means of utilizing small quantities of water in some of the districts where agriculture can be successfully carried on most of the time by rainfall alone.

In Utah the field work was carried on in cooperation with the State engineer's office by E. R. Morgan. It included the installation of flumes and weirs for the measurement of water on Weber River, preparatory to a determination of the duty of water from that stream. A cooperative agreement has been entered into with the State experiment station for a study of the most economical methods of distributing and using water and for the inauguration of some experiments in drainage for the relief of overflowed lands and the removal of alkali.

The irrigation investigations in Wyoming were carried on in part by the regular force of the Cheyenne office and in part through a cooperative agreement with the State experiment station, Prof. B. P. Fleming of the station being in charge.

INVESTIGATIONS IN THE SEMIARID DISTRICTS.

Between the eastern part of Texas, Oklahoma, Kansas, Nebraska, and the Dakotas, and the distinctively arid country which lies at the western border of these States, there is a broad strip of country which extends from the northern boundary of the United States almost to the Gulf of Mexico. In this belt there is plenty of rain in many seasons to produce crops, but in others agriculture without irrigation is a failure. In all years the period in which irrigation is necessary is of brief duration only. In these sections farmers are confronted by two problems: How to make the limited water supply of that region available, and how to utilize it to the best advantage. Owing to the absence of large rivers and the intermittent character of the streams, farmers must depend upon two sources for their water supply—on what they can pump out of the subsoil of their farms and what they can store in small reservoirs. In this region there have been recurring periods of wet and dry years, which have peopled and depopulated certain sections three or four times. Rainy years attract farmers and dry years drive them away. A special system of agriculture must be worked out for this part of the country, in which the total holdings of land will be comparatively large, but where each settler will be fortified by having from 10 to 20 acres of ground which he can irrigate and which will assure him every year, whether it be a wet or a dry one, an ample supply of vegetables from his garden, a few fruit trees, and enough alfalfa and forage to support his milch cows and other live stock.

This Office has received numerous petitions from individuals and associations of farmers to take up the study of irrigation methods suited to this region and to outline plans for agricultural development based thereon. We made a beginning by cooperating this year with the station established by the State of Kansas at Hays. This work was under the personal direction of J. G. Haney, a member of the station staff of the Kansas Experiment Station. It included the installation of a pumping plant, the measurement of water used in irrigation, and a record of the cost and of the increased yields of crops.

In South Dakota the investigations were carried on by A. B. Crane, professor of civil engineering in the State Agricultural College, and included a study of irrigation from artesian wells in the James River Valley.

The investigations in Nebraska are carried on under a cooperative agreement with the State experiment station and are under the personal direction of Prof. O. V. P. Stout. They included studies of the duty of water under a canal system near Culbertson, which lies on the border line between the humid and semiarid States, and will help to determine the amount of water required and the best methods of its

utilization under the peculiar climatic conditions of this part of the country. Professor Stout also assisted in the interstate water-right studies carried on on the Platte River.

INVESTIGATIONS IN THE HUMID REGION.

In the humid region we are cooperating with the State experiment stations of Wisconsin, Missouri, and New Jersey in the study of the advantages of irrigation and the best means of applying water to crops in the eastern half of the United States.

An investigation of the requirements of cranberry irrigation is being carried on in cooperation with the State experiment station of Wisconsin, under the direction of Prof. A. R. Whitson. It includes a study of both the irrigation and drainage requirements of this crop. Wisconsin has provided for the carrying out of this work, and a lease has been secured from the Wisconsin Cranberry Growers' Association of about 9 acres of land 10 miles southwest of Grand Rapids. In this the association has already planted a number of different varieties of vines representing all those grown in the United States and Alaska, as well as others received from foreign countries, including Norway, Russia, Siberia, and Canada. With this there are 2 acres of standard vines, and the results of applying different quantities of water and different methods of application will be studied. A small reservoir has been constructed and measurements of seepage and evaporation have already been begun. The success of the cranberry industry depends upon the proper use and control of water. It must be applied at the right time and withdrawn quickly at the right time. Until the last few years there was no attempt made in growing cranberries in Wisconsin to exercise control over the water. If nature failed to cover the vines at the right time or uncovered them at the wrong time the crop would suffer. The severe drought of 1895 almost destroyed the industry in that State. With the revival of this industry have come better methods. Dams are being built to collect the surface water. Canals are being constructed to carry water pumped from the streams. The development of the industry and the extension of the area under cultivation have brought new difficulties. More water is needed, requiring larger ditches. Greater uniformity in the matter of drawing off water is imperative to prevent the operations of one neighbor damaging those below him. Much litigation has been caused by a lack of arrangements for cooperation and by the construction of inadequate works. This calls for more knowledge as to the principles which should govern in this work, which this Office is endeavoring to collect and provide. In order to make this effective expert direction is needed. Through the lack of this, many costly failures have occurred. The work undertaken is being prosecuted along the following lines:

(1) The collection of data from growers as to the amount of water used and their methods of applying it.

(2) The determination of losses from seepage and evaporation from ground covered by vines as well as from reservoirs.

(3) The determination of the effect of standing water at different temperatures on berries and vines in various stages of development and under various conditions of weather.

(4) The determination of the coefficient of resistance of peat ditches used for carrying water to and from the vines.

(5) The determination of the most effective methods of using water to prevent injury from frost.

(6) The effect upon the cranberry marshes of the drainage of adjacent areas for farm purposes.

The results of the present year, while not conclusive, show how greatly the success of this industry will be promoted by an efficient system of canals for getting the water onto the ground and getting it off. On June 11 of this year there was danger of frost. Those who had proper ditches saved their crops. Those who were not so provided lost them. A conservative estimate of the loss in the Cranmoor and Mather regions places this loss at \$25,000. The damage due to improper drains in this region, which prevented the removal of the water in time, was greater than that from frost, so that from these two items in the two districts there was a net loss this year of over \$75,000, a sum which would probably be nearly sufficient to construct a system of canals to meet the demands of both districts.

The investigations in Missouri were carried on under a cooperative arrangement with the Missouri State Experiment Station under the direction of Prof. F. B. Mumford, acting dean and director. The results of this season are in accord with those of previous years, and tend to prove that irrigation will pay in the cultivation of orchard and garden crops.

In New Jersey Prof. E. B. Voorhees, director of the State experiment station, continued his experiments for this Office in the irrigation of garden crops and small fruits and in the best means of preventing losses from ditches in the irrigation of sandy lands. He also collected the results of practical experience in irrigation of a large number of market gardeners in the vicinity of New York and Boston. These reports give the results of irrigation for periods varying from one to twenty-five years, and all those who have irrigation plants intend to maintain them.

The duty of water was measured in the rice district of Louisiana and Texas at five different stations, under the direction of Prof. W. B. Gregory, of Tulane University, and Prof. M. A. Aldrich carried on some studies in legal and social questions growing out of the diversion of Southern streams. Prof. Elwood Mead and C. G. Elliott were

called upon for advice by rice growers of South Carolina, and gave some time to a study of the questions involved.

DRAINAGE INVESTIGATIONS.

The drainage investigations were carried on by C. G. Elliott, expert in charge, who gave advice on a large number of important projects, the carrying out of which will involve an outlay of nearly one and one-half million dollars. He also visited a number of localities and conferred with representatives of communities in regard to the engineering features of proposed drainage improvements and the legal and social issues involved in the organization of districts for the carrying out of these improvements. The demands on this Office for advice and information concerning the broad problems of farm drainage have become too great to be attended to by one person and have made it necessary to employ another expert.

LEGAL AND ECONOMIC INVESTIGATIONS.

The appropriation for these investigations requires us to report "upon the laws as affecting irrigation and the rights of riparian proprietors and institutions relating to irrigation and upon the use of irrigation waters, at home or abroad." The reason for requiring such reports needs no explanation to anyone familiar with Western conditions. Many of the rivers of the arid region are long and affect the welfare of several States. The distribution of these rivers among individuals, communities, and States is as complex a problem in transportation as the operation of a railroad or an express system and requires the same kind of systematic organization. The studies heretofore undertaken were planned to collect and present to the people concerned the facts relating to the operation of existing institutions in concrete form.

The only new work inaugurated this year was in compliance with a provision in the last appropriation bill which requires us to study the laws affecting irrigation and the rights of riparian proprietors. The laws for appropriating water by irrigators and those recognizing the rights of riparian proprietors come directly in conflict on the streams flowing east from the Rocky Mountains. They rise in States where the riparian doctrine is abrogated and flow into States where it is recognized. After consulting the governors and attorney-generals of Kansas, Nebraska, Wyoming, and Colorado, and the State engineers of Nebraska, Wyoming, and Colorado, all of whom welcomed this inquiry under the plans proposed, it was concluded to take up a study of the Platte River and gather the facts showing the number of ditches taking water out of the stream, the amount of the rights under the laws of appropriation, the use being made of the water, the value of the products, the amount of seepage that comes back from the diver-

sions, and the manner in which this diversion of the streams has interfered with natural conditions as they existed before diversions began. This work has been carried on, since the resignation of C. T. Johnston, under the direction of C. E. Tait, assisted by Frank Adams, W. B. Dunton, W. F. Bartlett, Professor Stout of the University of Nebraska, and Professor Fleming of the University of Wyoming. Prof. Richard T. Ely, of the University of Wisconsin, has been engaged as a special expert to study the social and economic questions involved. The collection of these data has been a laborious undertaking and one season is not sufficient to complete the work. It is believed that the report on this study will throw much needed light on many of the important practical features of irrigation bearing on the issues now being presented to the United States district and Supreme courts, and will aid in reaching right conclusions.

During 1903 this Office began the systematic collection of the results of the best irrigation practice as developed by irrigators and canal managers. We intend publishing bulletins thereon for the use of beginners in irrigation. The subjects dealt with were the preparation of land for irrigation and the design and construction of current wheels for lifting water from streams. Each of the agents of this Office was requested to send in descriptions and illustrations of the prevailing practice in the region where he was carrying on investigations and to describe any current wheels in use in his district. The bulletins giving the results of these reports will be published in a short time. The collection of similar data along other lines of irrigation practice will be continued during the coming year.

IRRIGATION PUBLICATIONS.

The publications on irrigation for the fiscal year ended June 30, 1903, included five bulletins, two Yearbook articles, and one circular. The subjects treated in these publications are as follows:

Irrigation Laws in Utah; Egyptian Irrigation; Plans of Structures in Use on Irrigation Canals in the United States; Report of Irrigation Investigations for 1902 in Utah, Idaho, Wyoming, Washington, Montana, California, South Dakota, Louisiana, Texas, Missouri, Wisconsin, New Jersey, and Hawaii; Storage of Water on the Cache la Poudre and Big Thompson Rivers in Colorado; Some Engineering Features of Drainage; Preliminary Plans and Estimates for Drainage of Fresno District, California.

THE AGRICULTURAL EXPERIMENT STATIONS IN THE SEVERAL STATES AND TERRITORIES.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute,
Auburn.

Department of the Alabama Polytechnic Institute.

GOVERNING BOARD.

Board of Trustees, Committee on Experiment Stations.

STATION STAFF.

J. F. Duggar, M. S., <i>Director; Agriculturist.</i>	A. McB. Ransom, M. S., <i>Second Assistant</i>
B. B. Ross, M. S., <i>Chemist.</i>	<i>Chemist.</i>
C. A. Cary, B. S., D. V. M., <i>Veterinarian.</i>	Thomas Bragg, M. S., <i>Third Assistant</i>
E. M. Wilcox, Ph. D., <i>Botanist.</i>	<i>Chemist.</i>
R. S. Mackintosh, B. Agr., <i>Horticulturist.</i>	T. U. Culver, <i>Superintendent of Farm.</i>
J. T. Anderson, Ph. D., <i>Assistant Chemist.</i>	J. M. Jones, B. S., <i>Assistant Animal Hus-</i>
C. L. Hare, M. S., <i>First Assistant Chemist.</i>	<i>bandman.</i>

H. O. Sargent, *Assistant Horticulturist.*

GENERAL OUTLOOK.

The Alabama Station has continued to devote much attention to the improvement of soils and the diversification of agriculture through the introduction of new crops and animal husbandry. For this reason the most extensive work of the station is that connected with the agricultural department, which is conducting feeding experiments with dairy and beef cattle and pigs, experiments in the improvement of beef cattle and sheep, and a large variety of field experiments with leguminous crops as soil renovators and converters of nitrogen, with forage and other field crops under fertilizers, with improved varieties of cotton and cowpeas, and with wheat and corn from different latitudes. Some attention is being given to a study of soil-derived and air-derived nitrogen in cowpeas in cooperation with the chemical department of the station. Farmers in all parts of the State are cooperating with the station in the variety, culture, and fertilizer tests of forage crops and other field crops. The chemical department is giving some attention to a study of the available plant-food in soils, the available phosphoric acid in the raw materials used in making commercial fertilizers, and in the making of sirup from sugar cane. The veterinarian is making a test of inoculation as a protection against

splenic fever in cattle, and of the toxic effects of cotton-seed meal on hogs. The botanist, among other things, is investigating the oil-producing power of numerous sorts of castor-oil beans. About 260 sorts have been grown this year in cooperation with one of the district agricultural schools. The station has also cooperated with the Bureau of Plant Industry of this Department in testing novelties introduced by the seed trade.

The agriculturist of the station has been made director, and the horticultural work has been organized as a separate department by the election of R. S. Mackintosh as horticulturist of the station and State horticulturist. By a recent act of the State legislature horticultural inspection has been provided for and placed in charge of the horticulturist. Arrangements have recently been made by which the department of agriculture of the station is to have increased funds from the fertilizer inspection, and it is hoped that the State will also provide for the holding of farmers' institutes without expense to the college and station. These changes will greatly relieve the station and place it in a position for more effective investigations, and yet much larger funds could be profitably utilized in the investigation of numerous problems in the restoration of agricultural areas through the introduction of animal husbandry, the more extensive use of legumes, of improved varieties of staple crops, and of modern methods of farm management.

LINE OF WORK.

The principal lines of work conducted at the Alabama Station during the past year were as follows: Botany—grasses, native trees, varieties of castor-oil beans, and of cotton; soils—renovation with manures and leguminous plants, inoculation experiments; analyses of fertilizers and food materials; field and pot experiments—fertilizers, barnyard manures, cereals, cotton, forage crops; horticulture—varieties of strawberries and other fruits and asparagus, irrigation of garden vegetables; plant breeding—cotton, cowpeas; diseases of plants; feeding and pasturing experiments with beef and dairy animals and hogs; diseases of animals; dairying—milk, butter, and cheese production.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Fees for the analysis of fertilizers	8,137.06
Farm products	566.85
Miscellaneous	377.69
Total	24,081.60

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 121-124 and the Annual Report for 1902. The bulletins include the following subjects: Dairy herd record and creamery notes; grazing and feeding experiments with pigs; vetch, cowpea, and soy-bean hay as substitutes for wheat bran; and the horticultural law—notes on some of the insects and fungus diseases affecting horticultural crops.

Canebrake Agricultural Experiment Station, Uniontown.

GOVERNING BOARD.

Board of Control: R. R. Poole (*Commissioner of Agriculture, ex officio*), *Montgomery*; J. Huggins, *Newbern*; A. Sledge, *Whitsett*; G. D. Stollenwerck, *Uniontown*; W. M. Munford, *Uniontown*; J. B. Garber, *Laneville*.

STATION STAFF.

J. M. Richeson, M. S., *Director; Secretary.* William Munford, *Treasurer.*
J. F. Connor, V. M. D., *Veterinarian.*

GENERAL OUTLOOK.

The work of the Canebrake Station has been devoted as heretofore to field experiments with legumes, fertilizers, and barnyard manure as means of improving the depleted soils of the prairie region. Cowpeas, melilotus, velvet beans, vetches, and clover have been grown as soil correctives and nitrogen gatherers, and some attention has been given to drainage, methods of cultivation, and experiments with upland rice, flax, and fruits.

LINES OF WORK.

The principal lines of work conducted at the Canebrake Station during the past year were as follows: Soil improvement, field experiments, horticulture, floriculture, diseases of plants, and diseases of animals.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation.....	\$2,493.76
Farm products.....	383.75
Total.....	2,877.51

No publications have been received from this station during the past year.

Tuskegee Agricultural Experiment Station, Tuskegee.

Department of the Tuskegee Normal and Industrial Institute.

GOVERNING BOARD.

Board of Regents: R. R. Poole, *Montgomery*; George W. Campbell, *Tuskegee*; Chas. W. Hare, *Tuskegee*; Lewis Adams, *Tuskegee*; Booker T. Washington, *Tuskegee*; Warren Logan, *Tuskegee*.

STATION STAFF.

G. W. Carver, <i>Director.</i>	G. W. Owens, <i>Dairying.</i>
R. M. Atwell, <i>Superintendent of Farm.</i>	G. K. Gordon, <i>Dairying.</i>
C. W. Greene, <i>Practical Agriculture,</i> <i>Home Farm.</i>	A. F. Crawford, <i>Landscape Gardening.</i>
G. R. Bridgeforth, <i>Stock Raising.</i>	D. A. Williston, <i>Landscape Gardening.</i>
J. B. Brown, <i>Truck Gardening.</i>	C. J. Calloway, <i>Bureau of Nature Study.</i>

GENERAL OUTLOOK.

The Tuskegee Station has continued its demonstration experiments with various soil renovators, with the object of showing what can be done by the poor farmer of Alabama in building up a worn-out soil with little cash outlay. This has seemed desirable, because the majority of the negro farmers in the vicinity of Tuskegee are men of small means and are under the necessity of earning a living while bringing their land up to a condition of productiveness. Emphasis has been laid upon intensive methods of cultivation, and under these methods the station has shown results this year giving a net gain of nearly \$100 per acre. A series of experiments on fodder plants has just been brought to a close, and the results are being tabulated for publication. The station has cooperated with a number of farmers throughout the State in growing cotton, corn, cassava, and other forage and food plants. Cooperative work has also been carried on with other stations and with this Department. The extension work of the station, consisting largely of the distribution of leaflets among farmers, has been continued. Children's gardens have also been conducted in connection with the agricultural department of the Tuskegee Normal and Industrial Institute. The station is slowly acquiring a good equipment of farm implements and is in a better condition than formerly for conducting investigations.

LINES OF WORK.

The principal lines of work conducted at the Tuskegee Station during the past year were as follows: Field experiments, horticulture, diseases of plants, animal industry, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation.....	\$1,500
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PUBLICATIONS.

No publications have been issued, it having been found that the station could exert its influence most effectually through conferences of farmers.

ALASKA.

Alaska Agricultural Experiment Stations, Sitka, Kenai, and Copper Center.

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

C. C. Georgeson, M. S., <i>Special Agent in Charge, Sitka.</i>	R. W. De Armond, <i>Assistant at Sitka.</i>
F. E. Rader, <i>Assistant at Sitka.</i>	H. P. Nielsen, ^a <i>Assistant at Kenai.</i>
	J. W. Neal, <i>Assistant at Copper Center.</i>

GENERAL OUTLOOK.

During the fiscal year ended June 30, 1903, experiment stations were maintained at Sitka, Kenai, and Rampart. A new station was established at Copper Center, and cooperative investigations were carried on in a number of localities. The experimental work for the greater part included the growing of cereals and vegetables; methods of reclaiming, draining, and fertilizing land, and the curing and ensiling of crops. The distribution of seeds of hardy varieties of vegetables, cereals, and grasses has been continued and extended, seed having been distributed to more than 1,000 addresses during the year. The efforts that have been put forth in this direction have already produced many beneficial results, as is shown by the increasing number of gardens and other plats of ground which are brought under cultivation. An address list of about 1,500 names has been prepared, to which the publications of the station and other information are sent from time to time. The supervision of voluntary observers of the Weather Bureau in Alaska has been continued as in former years. There are now twenty meteorological stations supplied with instruments by the Weather Bureau which report to the experiment station at Sitka.

The new station, which has been opened in Copper Center in the valley of the Copper River, embraces a tract of about 775 acres, which has been temporarily withdrawn from entry by the Secretary of the Interior and set aside for the use of the station. During the past summer the special agent in charge of the Alaska stations visited this station and reports that about ten acres of land had been cleared, plowed, and seeded to spring crops, which consist chiefly of varieties of oats, barley, spring wheat, emmer, buckwheat, and grasses, and in spite of a backward spring, with the exception of the wheat, some of the varieties of all the cereals matured. Peas, radishes, and lettuce were being supplied on the table at this time and other hardy vegetables promised well.

At the Kenai Station there are now about 15 acres under cultivation, and it is planned to clear 10 acres more. All hardy vegetables did

^a Resigned November 1 and succeeded by P. H. Ross.

well, and buckwheat, oats, and barley matured. A log residence for the superintendent and a stock barn have been erected, the former containing also storeroom for grains, seeds, etc. A beginning has been made here in animal industry, a cow and a calf having been added to the live-stock equipment. During a period of 87 days in June, July, and August the cow gave 2,530 pounds of milk, or over 29 pounds per day, from a pasture of native grasses only.

At the Rampart Station work has been restricted owing to lack of help to attend to the experiments. Spring wheat, barley, and oats matured at this place, and winter rye, sown from seed matured in 1901, successfully passed through the winter and matured a crop of fine grain. These results, attained at a latitude of $65^{\circ} 30' N.$, aid in demonstrating some of the agricultural possibilities of the country. There were also very successful cooperative experiments on Wood Island with winter rye and spring wheat, barley, oats, grasses, and other forage plants and hardy vegetables.

At the Sitka Station additional work has been done on the headquarters and other buildings and a beginning made in horticultural work. A small nursery has been established, and about 400 trees, mostly apple trees, are being grown to furnish scions for grafting. Several hundred currant, raspberry, and other shrubs are being grown, and a start has been made with hardy ornamental shrubs for distribution. Hardy vegetables and cereals were grown as formerly. There is need of additional work on the buildings at this station, and a small propagating house is desired for carrying on the horticultural investigations, as well as inclosed yards for poultry. As the work progresses there is a greater demand for a scientific equipment at the Sitka Station. There is need of a chemist, botanist, and entomologist, with equipment for each. For some time to come the necessary investigations of the different stations along the lines of chemistry, botany, etc., could be conducted at the Sitka Station if the proper equipment were provided. It is also desirable to equip the station at Rampart, which is representative of the largest agricultural region in Alaska, embracing many thousands of acres. The limited experiments thus far conducted at this station have shown the practicability of agriculture in this region, and there is need of a permanent superintendent to extend the work, and of buildings, and an equipment of animals and implements. Additional buildings and equipment are also needed at Copper Center, which is also believed to be representative of a large agricultural area. Funds are needed also for the purchase of additional live stock for experiments in animal industry. The special agent recommends the establishment of a temporary cattle range on Kadiak Island, with a view of introducing some of the hardier breeds of cattle into Alaska. Southwestern Alaska is a natural range country, and Kadiak Island offers opportunities well adapted to this investigation.

LINES OF WORK.

The principal lines of work conducted at the Alaska stations during the past fiscal year were as follows: Field experiments with cereals, fiber plants, vegetables, and grasses; tests of methods of reclamation, drainage, and fertilization of land; curing and ensiling of forage crops; horticulture—propagating currant, gooseberry, and raspberry plants, experiments with hardy fruit trees, ornamentals, and strawberries; and meteorological observations.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation..... \$15,000

PUBLICATIONS.

The seventh report on the investigations in Alaska, giving a detailed account of the operations during the year 1903, has been prepared by the special agent in charge of Alaska investigations, and is given on page 313.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, Tucson.

Department of the University of Arizona.

GOVERNING BOARD.

Board of Regents: Winfield Scott (*Chancellor*), *Scottsdale*; Geo. J. Roskrige (*Secretary*), *Tucson*; J. M. Ormsby (*Treasurer*), *Tucson*; Mark J. Egan, *Clifton*; Gov. A. O. Brodie (*ex officio*), *Phoenix*; N. G. Layton (*Superintendent of Public Instruction, ex officio*), *Phoenix*.

STATION STAFF.

R. H. Forbes, M. S., <i>Director; Chemist; in charge of Farmers' Institutes.</i>	T. F. McConnell, jr. (<i>Phoenix</i>), <i>Animal Husbandman.</i>
A. J. McClatchie, M. A. (<i>Phoenix</i>), <i>Agriculturist, Horticulturist.</i>	J. J. Thornber, M. A., <i>Botanist.</i>
	W. W. Skinner, M. S., <i>Associate Chemist.</i>
S. M. Woodward, M. A., <i>Consulting Meteorologist.</i>	

GENERAL OUTLOOK.

The Arizona Station has continued to give prominence to irrigation investigations, range improvement, animal husbandry, and the introduction of new crops. The irrigation investigations are in cooperation with this Office and the range improvements with the Bureau of Plant Industry of this Department. During the year 49.2 square miles intended for observations in range improvement have been fenced and placed in condition favorable for the achievement of future results. The work with date palms (Pl. 1, fig. 1), also in cooperation with the Bureau of Plant Industry, has been very successful. There

are now 15 acres in palms and this year a small crop of Rhars and Deglet Noor dates was obtained on 3-year-old trees. The work is attracting much attention, but would-be planters can not secure suckers for starting an orchard. The station will not be able to supply any of these until 10 acres more are set out to palms. The work in animal husbandry has been interrupted by the resignation of the animal husbandman, who has gone to Nevada. He has been succeeded by T. E. McConnell, jr., formerly of Wisconsin, who has taken up some work on the improvement and care of milk, the feeding of dairy cows mainly with alfalfa used as a soiling crop, and the feeding of steers for beef. An experiment has also been made on the effect of barley added to alfalfa on the quality of pork. Some successful experiments with melons have been conducted at Phoenix. (Pl. I, fig. 2.) About 700 young *Eucalyptus rudis* are being propagated and will be distributed next spring. This has been found to be the best variety for Arizona conditions, being frost and drought resisting and honey producing. A study of the Colorado River water in cooperation with the U. S. Geological Survey has been continued.

The station is making very satisfactory progress considering the conditions under which it is working. It was given an appropriation of \$11,000 by the Territorial legislature last winter to be expended particularly in extending the date-palm experiments and improving the station farm, and for the dissemination of results of station work by means of publications, farmers' institutes, and short courses of instruction. Institute work, including the giving of short courses of instruction, was undertaken at Thatcher, in the Upper Gila region, and was cordially received. This evidence of good will on the part of the people of the Territory is very encouraging. The desert laboratory established near Tucson under the auspices of the Carnegie Institution is expected to be of material assistance to the station in the studying of native forage plants on the ranges under the control of the station. The work of the Arizona Station is now so well organized that it could profitably utilize larger funds in the more extensive study of the problems of irrigation, range improvement, and animal husbandry, and might in this way more effectually aid the agricultural development of the Territory.

LINES OF WORK.

The principal lines of work conducted at the Arizona Station during the past year were as follows: Chemistry—study of irrigation waters and their effects upon irrigated soils; botany; field experiments—cereals, forage crops; irrigation investigations; improvement of ranges; horticulture—date-palm growing, melons, vegetables, fruits, etc.; and feeding experiments—beef and dairy cattle, sheep, and hogs.



FIG. 1.—ARIZONA STATION—DEGLET NOOR DATE PALM THREE YEARS AFTER PLANTING AT TEMPE.



FIG. 2.—ARIZONA STATION—MELON EXPERIMENTS AT PHOENIX. ANIMAL HUSBANDRY PART OF FARM IN BACKGROUND.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
State appropriation.....	741.89
Farm products.....	1,694.21
Miscellaneous.....	53.06
Total.....	17,489.16

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 43-45 on utilizing our water supply, the river-irrigating waters of Arizona, and timely hints to farmers; indexes to Bulletins 1-32 and Annual Reports for 1890-1899; and the Annual Report for 1902. The Annual Report, in addition to matter of an administrative character, contains articles on strawberries, eucalypts, the melon plant louse, and the "manteca" disease, forage crops, dehorning fattening steers, and the dairy herd.

ARKANSAS.

Arkansas Agricultural Experiment Station, Fayetteville.

Department of the University of Arkansas.

GOVERNING BOARD.

Board of Control—Agricultural Committee: G. T. Breckenridge, *Paragould*; J. C. South, *Mountain Home*; C. C. Hamby, *Prescott*; H. S. Hartzog (*President University*), *Fayetteville*; W. G. Vincenheller, *Fayetteville*.

STATION STAFF.

W. G. Vincenheller, <i>Director</i> .	Ernest Walker, B. S. Agr., <i>Horticulturist</i> ,
R. R. Dinwiddie, M. D., <i>Pathologist</i> ,	<i>Entomologist</i> .
<i>Bacteriologist</i> .	C. L. Newman, B. S., <i>Agriculturist</i> .
J. F. Moore, B. S., <i>Chemist</i> .	

GENERAL OUTLOOK.

The work of the Arkansas Station during the past year has been largely a continuation of investigations started in former years. Pork production is one of the most promising lines of animal husbandry in the State and is, as it has been in previous years, one of the most prominent features of station work.

The station has made a very thorough study of the best succession of grazing crops for hogs, the poisonous effects of cotton-seed meal, and swine diseases. These experiments have shown that under

Arkansas conditions pigs can be profitably raised on alfalfa and peanuts with some grain to harden the meat. Cotton-seed meal seems to be suited to the latter purpose, and it has been found that, when fed to pigs at a daily rate of 0.25 per cent of the live weight of the pig, it accomplishes this result without injury to the animal. An interesting general result of the experiments on the poisonous effects of cotton-seed meal is that "the harmful effects of overfeeding with cotton-seed meal are manifested in all species of animals so far tested. Hogs exhibit no great excess of susceptibility over cattle when fed in doses proportionate to their weight." Experiments on other important features of this subject are being continued. The effect of "hog-ranching" according to the above system, as well as the residual effect of leguminous plants on the fertility of the soil, are being studied. This work has for its object the solution of the important question of increasing and conserving the fertility of the soil by simple farm methods. The cowpea has been found to be one of the most valuable crops for this purpose, and the station has in progress quite extensive experiments in the improvement of this plant. Digestion experiments with a number of animal fats and vegetable oils have given results which indicate that the vegetable oils are more completely digested than animal fats, that the digestibility of both fats and oils is increased by cooking, and that their digestibility decreases as their fluidity decreases.

The station is cooperating with this Department in testing a large number of imported varieties of apples. The substation at Newport has been discontinued and the work in pork production there transferred to Fayetteville, where it will be continued in connection with rotation and soil improvement experiments. An appropriation of \$1,000 has been secured from the State for the inspection and control of contagious diseases of animals. Several minor improvements in station equipment have been made, including the erection of an inexpensive equipment for poultry experiments, the moving of the barns to a more suitable location, and the planting of shrubbery and flowers for the beautification of the grounds. At the close of the year the director resigned and was succeeded by W. G. Vincenheller, who was at one time pomologist and institute worker at the station.

The station is in need of aid in the study of plant diseases and of additional funds for printing. Coincident with the recent revision of the mailing list a circular was sent out asking those who cared to have their names continued on the list to fill out and return the blanks. Over 90 per cent of the 5,500 recipients of this circular responded promptly and sent in the names of enough others desiring the station publications to increase the mailing list to over 20,000 names. This is an indication of one way in which the station might with additional funds reach a larger number of its constituents. It might reach many

more if some provision were made for holding farmers' institutes in the State. The president of the university with which the station is connected is starting the institute work, but can not accomplish much in this direction without additional State aid. It is hoped that such aid and also additional funds for the station will soon be provided.

LINES OF WORK.

The principal lines of work conducted at the Arkansas Station during the past year were as follows: Chemistry of foods—lard and oils used in cooking, effect of different feeds on the quality of the fat of hogs; field experiments—selection of wheat and oats, culture of corn in combination with cowpeas, soy beans, rape, peanuts, etc., for forage; horticulture—apples, peaches, small fruits, and garden vegetables, investigation of insecticides; plant breeding—cowpea; diseases of plants; feeding experiments—feeding and pasturing swine on peanuts, chufas, cotton-seed meal, etc.; and diseases of animals—swine plague, swine pest, and investigation of methods for applying vaccine.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products.....	914.79
Total.....	15,914.79

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 72-75, including reports on experiments with sweet potatoes, pork production and hog ranching, alfalfa, and the phosphate rocks of Arkansas.

CALIFORNIA.

Agricultural Experiment Station of the University of California, Berkeley.

Department of the University of California.

GOVERNING BOARD.

The Regents of the University: Governor G. C. Pardee (*ex-officio President*), *Sacramento*; Alden Anderson, 2 Morgan st., *Suisun City*; Arthur G. Fisk, *Mills Building, San Francisco*; T. J. Kirk (*State Superintendent of Public Instruction*), *Sacramento*; Benjamin F. Rush, *Suisun City*; R. J. Taussig, 26 Main st., *San Francisco*; Benjamin Ide Wheeler, 1820 *Scenic ave., Berkeley*; Isaias W. Hellman, *Nevada Bank, San Francisco*; Chester Rowell, *Fresno*; J. A. Waymire, *Alameda*; C. W. Slack, *Nevada Block, San Francisco*; J. B. Reinstein, 217 Sansome st., *San Francisco*; J. E. Budd, *Stockton*; Mrs. Phoebe A. Hearst, *Pleasanton*; A. W. Foster, *Mutual Life Insurance*

Building, San Francisco: Garret W. McEnerney, *Nevada Block, San Francisco;* C. N. Ellinwood, 2739 *Pacific ave., San Francisco;* J. W. McKinley, 254 *South Broadway, Los Angeles;* Rev. P. C. York, 1267 *Sixteenth ave., Oakland;* J. A. Britton, 632 *Waldworth ave., Oakland;* F. W. Dohrman, 124 *Sutton st., San Francisco;* C. S. Wheeler, 552 *Market st., San Francisco;* G. C. Earl, 2739 *Pacific ave., San Francisco.*

STATION STAFF.

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| E. W. Hilgard, Ph. D., LL. D., <i>Director; Chemist.</i> | H. M. Hall, M. S., <i>Assistant Botanist.</i> |
| E. J. Wickson, M. A., <i>Horticulturist.</i> | A. R. Ward, B. S. A., D. V. M., <i>Veterinarian, Bacteriologist.</i> |
| W. A. Setchell, ^a Ph. D., <i>Botanist.</i> | E. H. Twight, B. S., <i>Diplôme E. A. M., Viticulturist.</i> |
| R. H. Longbridge, Ph. D., <i>Agricultural Geologist and Soil Physicist (Soils and Alkali).</i> | E. W. Major, B. Agr., <i>Animal Industry.</i> |
| C. W. Woodworth, M. S., <i>Entomologist.</i> | H. J. Quayle, <i>Assistant in Entomology.</i> |
| R. E. Smith, B. S., <i>Plant Pathologist.</i> | C. A. Triebel, Ph. G., <i>Student Assistant in Agricultural Laboratory.</i> |
| Elwood Mead, M. S., C. E., <i>Irrigation Engineering.</i> | W. T. Clarke, <i>Assistant Superintendent of University Extension.</i> |
| M. E. Jaffa, M. S., <i>Assistant Chemist (Foods and Nutrition).</i> | A. V. Stubenrauch, M. S. A., <i>Assistant Horticulturist, Superintendent Substations.</i> |
| George Roberts, M. S., <i>Chemist (Fertilizer Control).</i> | S. Fortier, M. E., <i>Irrigation.</i> |
| G. W. Shaw, M. A., Ph. D., <i>Assistant Chemist (Sugars, Starches, Oils).</i> | A. P. Stover, B. S., <i>Assistant in Irrigation.</i> |
| G. E. Colby, M. S., <i>Assistant Chemist (Fruits, Waters, and Insecticides).</i> | Emil Kellner, <i>Foreman of Grounds.</i> |
| | C. A. Colmore, B. S., <i>Clerk to Director.</i> |
| | W. H. Volch, <i>Temporary Assistant Entomologist.</i> |

OUTLYING STATIONS.

San Joaquin Valley Station: John Tnolty, *Patron, Tulare;* Julius Forrer, *Foreman, Tulare.*

Southern California Station: J. E. McComas, *Patron, Pomona;* James W. Mills, *Foreman, Ontario.*

Chico Forestry Station: A. A. Knowlton, *Patron, Chico;* J. H. Ooley, *Workman in Charge.*

Santa Monica Forestry Station: Roy Jones, *Patron, Santa Monica;* William Shmitt, *Foreman, Santa Monica.*

Poultry Experiment Station: H. O. Woodworth, *Foreman, Petaluma.*

GENERAL OUTLOOK.

The California Station has continued to investigate a large number of problems related to the principal agricultural and horticultural interests of the State. During the year a considerable amount of entomological work has been closed and the results published; also some viticultural and beet-sugar work. In these lines and in horticulture considerable new work has been undertaken, and a plant pathologist, who has inaugurated investigations on asparagus rust, has been added to the staff. The entomologist is cooperating with individuals, county officers, and other Pacific coast entomologists in studies of the codling moth, red spider, peach borer, and peach worm.

^a On leave.

The horticulturist cooperates with farmers in a number of ways, including tests of application of fertilizers, green manures, etc.; the plant pathologist with the California Asparagus Growers' Association in his work on asparagus rust; and the animal pathologist with stockmen on diseases of animals. With this Office the cooperative enterprises include irrigation and nutrition investigations; and with the Bureau of Chemistry of this Department, investigations of the gluten content of wheat, the influence of environment on the sugar content of muskmelons, the available plant food in soils, and sugar beets.

Members of the staff have assisted as heretofore in the farmers' institute work and find that a limited amount of such work aids them in keeping informed on matters requiring investigation. The inspection work of the station is growing. A recent law adds fertilizer control to the duties of the station and provides funds for the inspection. This has made possible the addition of another chemist to the staff, which has also been strengthened by the addition of a plant pathologist as noted above, and an assistant entomologist. The Southern Coast Range Substation at Paso Robles and the Sierra Foothills Substation at Jackson have been closed. At the Southern California Substation, Pomona, a contract has been made for an adequate water supply, and additions to the pipe lines and the capacity of the reservoir have been made. At the San Joaquin Valley Substation, Tulare, a complete pumping plant and pipe-line system for irrigation have been installed. At the Chico Forestry Substation a workman's cottage has been erected, thus permitting permanent residence and closer supervision of work. The last legislature granted the Berkeley Station \$3,000 for viticultural investigations and \$5,000 for the establishment of a poultry experiment station at Petaluma. This station is to be under the supervision of the director of the Berkeley Station and its objects are to study the diseases of poultry; the value of poultry foods for the production of flesh, fat, eggs, and feathers; methods of sanitation; and means of promoting the poultry interests of the State. The station has also had some assistance from individuals and associations for special investigations. The people in two counties raised \$2,500 for work on the codling moth. Another county pays the salary of an assistant entomologist, who is working on the red spider, and several associations and commissions interested in cooperative work have supplied various amounts.

From the way in which the people of the State through their legislators and the people of certain localities and different associations interested in special investigations are supporting the California Station by giving funds for special investigations and otherwise aiding these enterprises, it is evident that the work of the station is highly appreciated. The vast resources of this State render it necessary that the station have larger funds to investigate the

problems arising in different localities and in connection with various industries, and it is hoped that provision will be made soon for liberal funds which shall be more permanent than the irregular appropriations and donations heretofore given.

LINES OF WORK.

The principal lines of work conducted at the California Station during the past year were as follows: Physics, chemistry and geographical distribution of soils; bacteriology; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; beet-sugar chemistry; chemistry of foods and feeding stuffs; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; and plant pathology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products	1,243.14
Total	16,243.14

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 141-146 and 148 on experiments with deciduous fruits at Paso Robles, grasshoppers in California, the California peach-tree borer, the peach worm, the red spider of citrus trees, new methods of grafting and budding vines, and resistant vines and their hybrids. A special seed bulletin on the distribution of seeds and plants was also received.

COLORADO.

Agricultural Experiment Station, Fort Collins.

Department of the State Agricultural College of Colorado.

GOVERNING BOARD.

The State Board of Agriculture: P. F. Sharp (*President*), *Denver*; A. M. Hawley (*Secretary*), *Fort Collins*; Whitney Newton (*State Treasurer*), *Denver*; George A. Webb (*Local Treasurer*), *Fort Collins*; B. F. Rockafellow, *Canyon City*; Mrs. E. F. Rountt, *Denver*; Jesse Harris, *Fort Collins*; Harlan Thomas, *Denver*; J. L. Chatfield, *Gypsum*; B. U. Dye, *Rockyford*; E. H. Grubb, *Carbondale*; Governor J. H. Peabody (*ex officio*), *Denver*; B. O. Aylesworth (*ex officio*), *Fort Collins*.

STATION STAFF.

L. G. Carpenter, ^a M. S., <i>Director; Irrigation Engineer.</i>	F. M. Rolfs, B. S., <i>Assistant Horticulturist.</i>
C. P. Gillette, M. S., <i>Entomologist.</i>	A. M. Hawley, <i>Secretary.</i>
W. P. Hadden, M. A., Ph. D., <i>Chemist.</i>	A. D. Milligan, <i>Clerk, Stenographer.</i>
Wendell Paddock, M. S., <i>Botanist, Horticulturist.</i>	F. C. Alford, B. S., <i>Assistant Chemist.</i>
G. H. Glover, M. S., D. V. M., <i>Veterinarian.</i>	Earl Douglass, B. S., <i>Assistant Chemist.</i>
W. L. Carlyle, B. S. A., <i>Animal Husbandman.</i>	R. E. Trimble, B. S., <i>Assistant Meteorologist, Irrigation Engineer.</i>
A. H. Danielson, B. S., <i>Agronomist.</i>	S. Arthur Johnson, M. S., <i>Assistant Entomologist.</i>
J. E. Payne, M. S., <i>Field Agent.</i>	P. K. Blinn, B. S., <i>Field Agent, Arkansas Valley Substation, Rockyford.</i>

GENERAL OUTLOOK.

The Colorado Station has continued lines of work formerly in progress, giving considerable attention to irrigation investigations, the utilization of by-products of the sugar beet, and horticultural investigations. The chemist has made digestion experiments with sheep on coarse fodders, and the agriculturist soiling experiments with cows and feeding experiments with pigs. The results of a number of feeding experiments with cows, pigs, and lambs have been published. The chemist is also studying the changes in the composition and character of the solids and sediment of irrigation waters at different stages, and also in stored water. The horticulturist is studying the Rhizoetonia of potatoes—the cause of large tops and no tubers, and conducting a number of experiments in cooperation with a large number of farmers to secure varieties resistant to Rhizoetonia. He is also conducting cooperative experiments with fertilizers for fruit trees. The experiments in cooperation with this Department now include investigations of the gluten content of wheat, sugar-beet investigations, the influence of environment on the sugar content of muskmelons, and the available plant food in soils with the Bureau of Chemistry; investigations of the conditions and limitations incident to the extension of the dairy industry in the short-grass country between the Mississippi Valley and the Rocky Mountains with the Bureau of Animal Industry. On the farm the breeding and selection of macaroni wheats have been given attention, and there have also been experiments with varieties of wheat in the San Luis Valley to secure an earlier-ripening variety. Range experiments have been in progress on a tract belonging to the college farm.

The station has now practically closed down its substation work. The Arkansas Valley Substation has been rented to a progressive graduate of the college, who will do some experimenting for the station to make further tests of some things which have been tried there.

^aOn leave.

The Cheyenne Wells farm is also leased. The station maintains two field agents, one in the Arkansas Valley and one on the plains, who have been doing considerable useful work in a practical way and in the dissemination of information, the collection of data, etc. A reservoir with an area of 50 acres and an inlet for conducting storm water from an extensive watershed have been under construction during the year, and a structure for a central heating plant is nearing completion. The last legislature made an appropriation of \$40,000 for a building for the department of civil and irrigation engineering at the college, in which provision will also be made for the office of the station director. Several changes in the station staff, especially among assistants, have occurred during the year. The vacancy in the position of professor of agriculture in the college and agriculturist of the station has been filled by the election of W. L. Carlyle, of the University of Wisconsin. The director of the station has been made State irrigation engineer, but still retains his position in the station.

The Colorado Station has investigations of considerable importance in progress. The most extensive and important problems under consideration are those relating to irrigation, and it is much to be desired that nothing shall interfere with the vigorous and systematic prosecution of these investigations. The farm operations of this station need to be more fully put under the control of its expert officers. Lack of funds has compelled the station to restrict its work in a number of directions, including especially horticulture and animal husbandry, and it is hoped that means may be provided soon for extending the work of the station along these important lines.

LINE OF WORK.

The principal lines of work conducted at the Colorado Station during the past year were as follows: Chemistry—analysis of soils and irrigation waters, sugar-beet investigations, studies of methods of analyzing feeding stuffs, etc.; field experiments—variety tests of wheat and oats for different altitudes; horticulture; diseases of plants; entomology—study of the codling moth, grasshoppers, various borers and leaf rollers, cutworms, and insects working on sugar beets and cantaloupes; irrigation—use of water, measurements of losses from ditches, studies of means for economizing water, measurements of seepage on the Platte, the Arkansas, the Rio Grande, and their tributaries.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products.....	133.67
Miscellaneous, including balance from previous year.....	994.05
Total.....	16,127.72

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 72-81 and the Annual Report for 1902. The bulletins include a soil study—IV, the ground water; the feeding value of beet pulp; swine feeding in Colorado; lamb feeding experiments; feeding beet pulp to lambs; unirrigated lands of eastern Colorado; the tomato industry of the Arkansas Valley; treatment of stinking smut in wheat; laying down peach trees, and onion growing in the Cache la Poudre Valley. The Annual Report contains the usual matters of an administrative nature and reports from the different departments.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

GOVERNING BOARD.

State Board of Control: Governor Abiram Chamberlain (*President*), *Hartford*; W. H. Brewer (*Secretary*), *New Haven*; E. H. Jenkins (*Treasurer*), *New Haven*; W. O. Atwater, *Middletown*; Edwin Hoyt, *New Canaan*; J. H. Webb, *Box 1425, New Haven*; T. S. Gold, *West Cornwall*; B. W. Collins, *Meriden*.

STATION STAFF.

E. H. Jenkins, PH. D., <i>Director.</i>	G. P. Clinton, S. D., <i>Botanist.</i>
A. L. Winton, PH. B., <i>Chemist.</i>	V. E. Cole, <i>Librarian, Clerk.</i>
T. B. Osborne, PH. D., <i>Chemist.</i>	L. M. Brautlecht, <i>Assistant Clerk.</i>
A. W. Ogden, PH. B., <i>Chemist.</i>	William Veitch, <i>in charge of Buildings and Grounds.</i>
M. Silverman, PH. B., <i>Chemist.</i>	Hugo Lange, <i>Laboratory Assistant.</i>
I. F. Harris, PH. B., <i>Chemist.</i>	J. B. Olecott, <i>in charge of Grass Garden (South Manchester).</i>
E. Monroe Bailey, <i>Chemist.</i>	William Pokrob, <i>Laboratory Assistant.</i>
W. E. Britton, PH. D., <i>Entomologist.</i>	V. L. Churchill, <i>Sampling Agent.</i>
Walter Mulford, F. E., <i>in charge of Forest Work and State Forester.</i>	

GENERAL OUTLOOK.

The lines of work at the Connecticut State Station have not been changed or enlarged during the past year. Progress has been made, however, in the increased amount of work done. Considerable investigation is being conducted on the microscopy of food adulterations, which is of a fundamental character and is of widespread usefulness. Work of this kind has been done with edible berries, certain cultivated sorghums, and seeds found in wheat screenings. Chemical studies of considerable permanent value were made on the effect of roasting on the cocoa bean and on the composition of authentic samples of cocoa beans and shells. The investigation of vegetable proteids continues

to be one of the leading lines of strictly scientific investigation. The work of the station forester is increasing popular interest in the utilization of waste lands for timber growth. Water companies are realizing the value of timber growth as a protection to watersheds both in conserving the rainfall and in lessening the danger of infection. The station has planted valuable timber on 100 acres of waste land in order to test experimentally different ways of planting and caring for the trees and to furnish an object lesson in forest management. The experiments with tobacco grown under shade have been continued, and it is the opinion of the station authorities that there is a future for the production of Sumatra leaf in this country when experience in handling the leaf has been gained. At the present time much of the crop is spoiled in the process of fermenting. The station is cooperating with the Bureau of Soils of this Department in testing tobacco seed imported from Sumatra, with the Bureau of Plant Industry in tests of novelties introduced by the seed trade and studies of the alfalfa plant, and with the Bureau of Forestry in tree planting experiments.

The inspection work of this station is growing steadily in variety and amount and absorbs an increasing amount of its energy. The work now includes the inspection of fertilizers, foods, feeding stuffs, orchard pests, and dairy apparatus. The State does not always provide adequate means for all of this work, so that it becomes something of a financial burden. In addition to the more practical enterprises the station is doing a large amount of strictly scientific work of great value and its influence is being felt throughout the State.

LINES OF WORK.

The principal lines of work conducted at the Connecticut State Station during the past year were as follows: Analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; chemistry—study of vegetable proteids; diseases of plants; horticulture—fertilization of orchards and study of the anatomy of fruits; forestry; field experiments—tobacco, grasses for turf making and pasture; and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$7,500.00
State appropriation.....	15,500.00
Individuals.....	10,340.00
Fees.....	3,019.64
Farm products.....	61.97
Miscellaneous.....	20.29
Total.....	<u>36,441.90</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Part IV of the Annual Report for 1901, containing articles on the examination of Babcock apparatus, fertilization of peach orchards, tobacco growing, composition of feeding stuffs, the nucleic acid of the wheat embryo, and the report of the forester; Bulletins 139-143 on the apple-tree tent caterpillar, the white fly or plant-house aleurodes, commercial feeding stuffs in the Connecticut market, spray calendar, and two common scale insects of the orchard; and Parts I and II of the Annual Report for 1902 devoted, respectively, to fertilizers, and the second report of the State entomologist.

Storrs Agricultural Experiment Station, Storrs,^a

Department of the Connecticut Agricultural College.

GOVERNING BOARD.

Board of Trustees: Governor Abiram Chamberlain (*ex-officio President*), *Hartford*; E. H. Jenkins (*ex-officio Vice-President*), *New Haven*; George A. Hopson (*Secretary*), *East Wallingford*; B. C. Patterson, *Torrington*; E. S. Henry, *Rockville*; George S. Palmer, *Norwich*; D. W. Patten, *North Haven*; C. A. Capen, *Willimantic*; A. J. Pierpont, *Waterbury*; L. J. Storrs, *Spring Hill*.

STATION STAFF.

L. A. Clinton, M. S., <i>Director; Agriculturist.</i>	H. L. Garrigus, B. Agr., <i>Assistant in Field Experiments.</i>
A. G. Gulley, M. S., <i>Horticulturist.</i>	E. R. Bennett, B. S., <i>Assistant Horticulturist.</i>
W. O. Atwater, Ph. D., <i>Supervisor Nutrition Investigations (Middletown).</i>	W. M. Esten, M. S., <i>Laboratory Assistant (Middletown).</i>
H. W. Conn, Ph. D., <i>Supervisor Dairy Bacteriology (Middletown).</i>	B. F. Koons, Ph. D., <i>Consulting Entomologist.</i>
C. L. Beach, B. S., <i>Dairy Husbandman.</i>	B. B. Turner, Ph. D., <i>Consulting Chemist.</i>
W. A. Stocking, jr., B. S. A., <i>Assistant Bacteriologist.</i>	E. H. Lehnert, B. S., D. V. S., <i>Consulting Veterinarian.</i>
E. H. Stoneburn, <i>Poultryman.</i>	E. A. White, B. S., <i>Consulting Botanist.</i>

GENERAL OUTLOOK.

The reorganization of this station and its work has continued during the past year and as a result the station has been put in better condition financially and as regards facilities for work than it has ever been in the past. The State appropriation of \$1,800 for food and dairy work has been divided equally between the supervisor of nutrition

^aTelegraph address, *Storrs via Willimantic*; railroad station, express, and freight address, *Engleville*.

investigations and the dairy department of the college, and the latter is now in position to take up much more extensive work in dairying, especially dairy bacteriology. This, in fact, is being made one of the main features of the station's work. The direction that this work is now taking is along lines of sanitary milk production and the methods of manufacturing soft cheeses, which at the present time are almost entirely imported. Although some of them are manufactured at one or two places in the United States, the process of manufacturing is a trade secret and not generally known. Under the direction of the supervisor of dairy bacteriology the station has succeeded in making a quality of cheese which is declared by experts to be equal to the imported article. This line of work promises to be of great importance and may result in the establishment of a new industry for New England. There have also been feeding experiments with dairy cows; tests of milk as a feed for pigs; experiments on the cost of raising calves, on legumes as cover crops, and in poultry culture, including the raising, feeding, and breeding of ducks, the production of squabs, and the cost of egg production.

The work in horticulture has included diseases of fruits and vegetables, diseases of fruit in cold storage, the thinning of fruit, and tests of varieties. The extensive orchards of a fruit grower at South Glastonbury, Conn., have been placed at the command of the station for experimental purposes, and a station officer has spent considerable time in carrying on experiments in these orchards during the past year. In cooperation with the Bureau of Plant Industry of this Department and with nearly one hundred farmers in the State, the station is conducting experiments with alfalfa to determine the areas where it can be successfully produced. Investigations on the food and nutrition of man have as heretofore been aided by a special appropriation from the State, and are carried on at Middletown in connection with similar investigations conducted under the auspices of this Office (see p. 64).

The chemist of the college has resigned, and has been succeeded by B. B. Turner, who becomes consulting chemist of the station. A small laboratory in the chemical building has been fitted up for station work. The professor of English in the college has been made editor of station publications. The old experiment plats, proving unsuited to the purpose, have been given up and a new location selected which will be put in condition. The station will fit up a laboratory for soil physics and seed testing in the agricultural building. The equipment has been considerably improved in several other particulars during the year. The station is coming more intimately in contact with the farmers of the State, and is endeavoring to conduct investigations that will be of interest to them. Its outlook as an agency to aid the agriculture of the State is much brighter than it has been in the past.

LINES OF WORK.

The principal lines of work conducted at the Connecticut Storrs Station during the past year were as follows: Food and nutrition of man and animals; bacteriology of dairy products; field experiments—fertilizers, soil tests, cover crops, nitrogen experiments; poultry experiments; dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$7,500.00
State appropriation	1,800.00
Miscellaneous	33.55
Total	9,333.55

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 24, on the history of a tuberculous herd of cows, Bulletin 25, on the covered pail as a factor in sanitary milk production, and the Annual Report for 1901. The latter contains in addition to administrative reports the records of meteorological observations, and reports on the following: An experiment on soil improvement, pot experiments with nitrogenous fertilizers, field experiments with fertilizers, the digestibility and availability of food materials.

DELAWARE.

The Delaware College Agricultural Experiment Station, Newark.

Department of Delaware College.

GOVERNING BOARD.

Board of Trustees—Committee on Agriculture: George G. Kerr (*Chairman*), *Newark*; James Hossinger, *Newark*; Manlove Hayes, *Dover*; Daniel W. Corbit, *Odessa*; S. H. Messick, *Bridgetown*.

STATION STAFF.

Arthur T. Neale, M. A., Ph. D., <i>Director</i> ;	C. L. Penny, M. A., <i>Chemist</i> .
<i>Agriculturist</i> .	C. O. Houghton, B. A., <i>Entomologist</i> .
F. D. Chester, M. S., <i>Mycologist</i> .	C. O. Smith, B. S., <i>Assistant Bacteriologist</i> .
G. P. Close, M. S., <i>Horticulturist</i> .	

GENERAL OUTLOOK.

The lines of work pursued by the Delaware Station during the past year do not differ materially from those of previous years. Some of the features given especial prominence are studies in soil bacteriology

and chemistry, dairy husbandry, animal diseases, the introduction of the proper method of spraying and orchard management in the State, and the study of cover crops for orchards in cooperation with the Bureau of Plant Industry of this Department. The station is also cooperating with the Division of Entomology in studying the San José scale and Asiatic ladybird. A test of a mercury vapor electric light in forcing lettuce and celery under greenhouse benches is being planned. At the close of the year the professor of agriculture in the college and the meteorologist of the station resigned and has been succeeded by James A. Foord, formerly of Cornell University and station. A building, formerly occupied in part by the college for a gymnasium and other purposes, has now been turned over exclusively to the station. It has been moved and refitted and will add materially to the station equipment. In the college with which the station is connected an especial effort is being made to develop agricultural courses, and just now considerable attention is being given to short courses. The station council system has been abandoned and the administrative policy is practically the same as it was before the council system was adopted. The college and station have only a very limited area of land for purposes of instruction or investigation, and additional funds might profitably be used in the purchase and equipment of a farm. The station should also have additional funds for the purpose of developing experiments in agronomy and scientific investigations in other lines of work. Many of the difficulties which this station and the college with which it is connected have encountered in the development of their work have been due to a lack of sufficient financial support from the State.

LINES OF WORK.

The principal lines of work conducted at the Delaware Station during the past year were as follows: Chemistry; bacteriology—studies of nitrifying bacteria and nitrogen-assimilating bacteria; field experiments—cultural experiments with legumes and other forage and field crops, breeding experiments with cereals; horticulture—study of cover crops for orchards, pruning of orchards, varieties of fruits; diseases of plants—study of blights and other diseases of cantaloupes, canker of pears and apples, asparagus rust and other fungus diseases of fruits and vegetables; feeding experiments; diseases of animals; entomology—studies of insects attacking fruit and shade trees; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000
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A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 56-59 on some destructive caterpillars, sundry notes on plant diseases, the San José scale, and the codling moth.

FLORIDA.

Agricultural Experiment Station of Florida, Lake City.

Department of University of Florida.

BOARD OF TRUSTEES.

Board of Trustees: George W. Wilson (*President*), *Jacksonville*; F. E. Harris, *Ocala*; F. S. Stringer (*Secretary*), *Brooksville*; E. D. Beggs, *Pensacola*; C. A. Carson (*Vice-President*), *Kissimmee*; F. M. Simonton, *Tampa*; J. R. Parrott, *Jacksonville*; W. P. Jernigan (*Clerk*), *Lake City*.

STATION STAFF.

T. H. Taliaferro, C. E., Ph. D., <i>Director</i> .	A. L. Clayton, <i>Stenographer, Librarian</i> .
H. K. Miller, M. S., <i>Chemist, Vice-Director</i> .	F. C. Reimer, B. S., <i>Assistant Botanist, Horticulturist</i> .
H. A. Gossard, M. S., <i>Entomologist</i> .	R. A. Lichtenthaler, B. S., <i>Assistant Chemist</i> .
H. H. Hume, M. S., <i>Botanist, Horticulturist</i> .	W. E. Worthington, <i>Assistant in Field Experiments</i> .
C. F. Dawson, M. D., D. V. S., <i>Veterinarian</i> .	J. F. Mitchell, <i>Foreman of Farm</i> .
C. M. Conner, B. A., <i>Agriculturist</i> .	J. H. Jefferies, <i>Foreman of Gardens and Orchards</i> .
A. W. Blair, M. S., <i>Assistant Chemist</i> .	
W. P. Jernigan, <i>Auditor, Bookkeeper</i> .	

GENERAL OUTLOOK.

The Florida Station has made considerable progress in organizing the work of investigation during the past year in spite of the fact that several of its departments have been somewhat handicapped by the lack of sufficient competent assistance. There has been a commendable spirit of cooperation between different members of the staff. The botanist and horticulturist, the entomologist, and the chemist are doing especially effective work in this way on citrus fruits, including the study of varieties, culture, composition, insect pests, marketing, etc. The botanist and horticulturist has published during the year three of a series of bulletins on citrus fruits, and is collecting data for others of this series. His department has been moved to new quarters, giving better facilities for work, and a new greenhouse is now being constructed and additional land placed at his disposal. The entomologist has published a very complete monograph on the white fly, and

is also supplementing the work of the botanist and horticulturist on pecans by a study of pecan insects. The chemist is giving special attention to a study of the composition of Florida fruits and of pineapple soils, regarding which a bulletin has recently been published. He is also conducting experiments with pineapple fertilizers in cooperation with prominent pineapple growers which have given some unexpected and important results. He is cooperating with the Bureau of Chemistry of this Department in a study of the vegetable plant food in soils. The station is also cooperating with the Bureau of Plant Industry in testing novelties introduced by the seed trade, and with the Division of Entomology in studies of the San José scale and the Asiatic ladybird.

The agriculturist is making a thorough study of the relative agricultural value of velvet beans, cassava, and sweet potatoes, including culture and feeding experiments. It is considered especially important that the station work on cassava be repeated to settle beyond doubt its actual farm value. The experimental work with pineapples at Jensen has been continued on a very satisfactory cooperative basis, and the substation at Bocaraton has also been continued. A considerable portion of the wooded area of the new farm has been cleared. While this farm is to be devoted mainly to general farm operations, a part has been assigned to the botanist and horticulturist for experimental work, and another part to the entomologist for an orchard to test the limits of endurance of different fruit trees for different kinds of sprays. The new science building has been completed and is occupied by the different departments, with the exception of chemistry.

As stated above, the staff of the Florida Station are working together harmoniously in conducting their investigations, and yet the need of a separate director to organize and manage the station work as a unit is felt. The station is in need of additional funds for maintenance. With its present resources it is able to work effectively in only a few lines, and its chief officers are overburdened with details which should be attended to by competent assistants.

LINES OF WORK.

The principal lines of work conducted at the Florida Station during the past year were as follows: Chemistry—study of pineapple soils and of the food and fertilizer ingredients of pineapples; field experiments—cassava, corn, and other farm crops; horticulture—asparagus culture, blight of tomatoes, celery and cantaloupes, varieties of strawberries and dewberries, studies of citrus fruits, experiments with lettuce and pineapples under cover; feeding experiments with hogs, steers, and dairy animals; veterinary science—Texas fever and nature and causes of salt sickness; entomology—white fly, San José scale, pineapple insects, and pecan budworm.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Farm products	1,650.08
Total	16,650.08

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 61-66, including the following subjects: Two peach scales, the Peen-to peach group, packing citrus fruits, Texas cattle fever and salt-sick, the kumquats, and the Mandarin orange group. The bulletins on citrus fruits, kumquats, and the Mandarin orange group are to be followed by others, comprising a series on inquiries regarding citrus fruits.

GEORGIA.

Georgia Experiment Station, *Experiment.*^a

Department of Georgia State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Directors: O. B. Stevens (*President*), Atlanta; J. B. Park, jr. (*Secretary and Treasurer*), Greensboro; Walter B. Hill, Athens; H. C. White, Athens; G. M. Ryals, Savannah; P. E. Boyd, Leary; J. T. Ferguson, De Soto; J. H. Mobley, Hamilton; A. J. Smith, Conyers; N. B. Drewry, Griffin; Felix Corput, Cavespring; John Deadwyler, Maysville; George Gilmore, Warthen; William Henderson, Ocilla.

STATION STAFF.

R. J. Redding, <i>Director</i> .	J. M. Kimbrough, <i>Agriculturist</i> .
H. C. White, C. E., Ph. D., <i>Vice-Director</i> ; <i>Chemist</i> .	Claude L. Willoughby, B. Agr., <i>Dairyman</i> . Josephine M. Heyfron, <i>Stenographer</i> , <i>Ac-</i> <i>countant</i> .
H. N. Starnes, B. A., <i>Biologist</i> , <i>Horticul-</i> <i>turist</i> .	D. A. Duffee, <i>Foreman in Horticulture</i> .

GENERAL OUTLOOK.

Few changes in the lines of work were made at the Georgia Station during the past year. The results of investigations carried on indicate that subsoiling is not a justifiable practice on soils available to the station; that both cotton and corn should be planted in squares allowing cultivation both ways, and that the most effective commercial fertilizers on the upland soils of middle Georgia are (1) for corn, 10 parts of available phosphoric acid, 2 parts of potash, and 5 parts of nitrogen; (2) for cotton, 10 parts of available phosphoric acid, 3 parts of potash, and

^aTelegraph, freight, and express address, Griffin.

3 parts of nitrogen. Some new features have been introduced in animal husbandry and dairying. These include tests of cotton-seed meal and other concentrated feeds, a succession of soiling crops for dairy cows, and a herd record. Studies of the effect of different feeds on the quality (hardness) of butter, and tests of different kinds of silage have been planned. Investigations for the purpose of establishing a schedule of formulas for the safe use of Bordeaux mixture on peaches; fertilizer tests with peaches; a thorough and comprehensive test of the Stringfellow method of pruning peaches, apples, and cherries; tests of carbon bisulphid for weevils in grain, and the hybridization of citrus fruits have been undertaken. The culture of ginseng, which was discontinued in 1898, has been resumed.

The extensive vineyard of numerous varieties is being replaced by a limited number of approved varieties of grapes trained on different systems. Cooperative experiments with cantaloupes have been discontinued, but experiments will be continued at the station. The station is cooperating with this Office in nutrition investigations, with the Bureau of Plant Industry in testing varieties of corn, and with the Division of Entomology in studies of the San José scale and the Asiatic ladybird. The publication of press bulletins has been resumed and farmers' institutes are being developed under the auspices of the State College of Agriculture and Mechanic Arts at Athens, with the cooperation of station officials.

The work of this station is conducted on too narrow a basis to fully meet the needs of the agriculture of the State. Its most important work thus far has been in field and orchard experiments and these should be extended to different regions of the State. The investigations in animal husbandry and dairying should be put on a more scientific basis, and also be conducted on a larger scale as regards their practical features. The resources of the station might well be increased to enable it to enlarge its work along the lines indicated above.

LINES OF WORK.

The principal lines of work conducted at the Georgia Station during the past year were as follows: Field experiments—culture and fertilizer tests; horticulture—orchard and small fruits, celery, cantaloupes, forcing vegetables; pig feeding; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	784.67
Farm products	1,739.64
Miscellaneous	4,289.75
Total	<u>21,814.06</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules provided by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 57-59 on cantaloupe culture in Georgia, corn culture, and cotton culture; and the Annual Report of the station for 1902.

HAWAII.

Hawaii Agricultural Experiment Station, Honolulu.

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

Jared G. Smith, <i>Special Agent in Charge;</i> <i>in charge of Farmers' Institutes.</i>	E. C. Shorey, <i>Chemist.</i> F. E. Conter, <i>Farm Foreman.</i>
D. L. Van Dine, <i>Entomologist.</i>	J. E. Higgins, <i>Expert in Horticulture.</i>

GENERAL OUTLOOK.

During the fiscal year ended June 30, 1903, the work of the Hawaii Agricultural Experiment Station was in continuation of the various lines of investigation described in the previous reports, with such special increase as occasion demanded. Additional portions of the station lands have been brought under cultivation and some experiments begun which will require a number of years for completion. The permanent improvements, such as buildings, fences, irrigation plant, etc., have been extended as occasion required and funds permitted. A new building was erected for the use of the agriculturist and entomologist, and the irrigation plant extended by the addition of about 2,000 feet of pipe, thus enabling the more extended application of water for the lower portions of the station grounds. Numerous additions to the library have been made by purchase and otherwise, and it is fast becoming a valuable asset of the station. Provision has been made for an office and library building.

The experiments on taro rot and potato rot have been continued upon an enlarged scale. One of the diseases of the taro plant was held in check by proper attention to irrigation water and the application of proper fertilizers. The results obtained will have an important bearing on the production of this staple food crop. The so-called black rot of potatoes is in reality caused by two fungi. The true black rot may be combated by the use of Bordeaux mixture, but the other disease called "quick rot" is caused by a soil fungus which attacks plants through their roots and even causes whole fields to wilt and turn black within a few days. Experiments have been undertaken this

year in which the seed tubers were soaked in a solution of formalin before being planted, with results which seem to indicate the success of this method. Efforts are being made also to promote the growing of corn, which was formerly an important industry on the island of Maui. During a number of unfavorable seasons the corn has been badly affected with an aphid and the crops were practically failures. The station made arrangements whereby 10 acres of land were secured and planted to a number of the best varieties of corn from the Middle West and the New England States. The soil was worked deep and manured, fertilizers were applied, and thorough cultivation was given throughout the growing season. Through this method of cultivation corn was kept in excellent condition, while that planted in the usual way was practically worthless. Variety tests with tomatoes have been undertaken. A visit of inspection has been made by the agriculturist to Kauai, the most northern and geologically the oldest island of the group. Considerable attention has at one time been given to forestry on this island, and the ranchers are devoting more attention to the growing of forage crops and to rational methods of stock feeding than formerly. The station desires to cooperate in these enterprises and is doing so as far as its resources will permit. The Hawaiian Live Stock Breeders' Association has become interested in the station and its work and was instrumental to a considerable degree in securing the assistance given the station by the recent legislature. There is urgent need that the station take up investigations in animal husbandry, but it is unable to do so with its present working staff, equipment, and funds.

A collection is being made of the grasses and forage plants of the island, and the entomologist has engaged in a general warfare against injurious insects. The assistant agriculturist has given his attention mainly to fiber plants and has prepared a bulletin on the sisal hemp in Hawaii, as well as a press bulletin on Manila hemp. Experiments with vanilla and cacao have been started and plantations of these plants commenced. Some investigations have been inaugurated in growing cotton and tobacco and considerable success attained in growing Sumatra leaf under shade.

Different members of the station staff have from time to time visited the different islands for the purpose of investigating specific problems and of attending farmers' institutes which have been held in a number of localities and have been very successful. The legislature of Hawaii at its recent session appropriated \$16,800 toward the support of the station for the two years ending June 30, 1905. It includes \$10,000 for maintenance, \$2,000 for salary of chemist, \$3,000 for library and office building, \$1,500 for residence for chemist, \$600 for stenographer, and \$300 for farmers' institutes. The building of a small insectary is contemplated. Dr. E. C. Shorey has been appointed chemist of the station, and will take up among other things a study of the soils of Hawaii and the use of fertilizers. The support given to the station

by the people of Hawaii and the evident interest that they take in the investigations of the station and in the farmers' institutes conducted under the auspices of the station are encouraging.

LINES OF WORK.

The principal lines of work conducted at the Hawaii Station during the past year were as follows: Field experiments—varieties of cotton, hemp, sorghum, potatoes, taro, culture experiments; horticulture—experiments with strawberries, growing of grape cuttings; diseases of plants and animals—fusarium diseases of potatoes, taro rot, diseases of poultry; entomology—study of injurious insects and means for their repression.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$12,000.00
Farm products	600.85
Total	12,600.85

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 2 on the root rot of taro, Bulletin 3 on insecticides for use in Hawaii, and Press Bulletin 2 on the castor bean. The third report on the investigations in Hawaii, giving a detailed account of the operations during the year 1903, has been prepared by the special agent in charge of the Hawaii Station and is given on page 391.

Hawaiian Sugar Planters' Experiment Station, Honolulu.

GOVERNING BOARD.

Trustees of Hawaiian Sugar Planters' Association: W. G. Irwin, H. A. Isenberg, W. O. Smith, G. H. Robertson, F. A. Schaefer, H. P. Baldwin, E. D. Tenney, F. M. Swanzy, B. F. Dillingham.

STATION STAFF.

C. F. Eckart, <i>Director; Chief Chemist.</i>	Firman Thompson, <i>Assistant Chemist.</i>
S. S. Peck, B. S., <i>First Assistant Chemist.</i>	A. E. Jordan, <i>Assistant Chemist.</i>
F. R. Werthmueller, B. S., <i>Assistant Chemist.</i>	E. G. Clark, <i>Field Assistant.</i>

GENERAL OUTLOOK.

The work of this station during the past year has been continued along the same lines as formerly, and has included chemical investigations on the manufacture of sugar and the investigation of sugar-house products, soils, fertilizers, and irrigation waters, and field work, including irrigation of cane, variety tests of cane, fertilizer experiments, and other cultural investigations bearing on the economic limitations of intensive agriculture.

PUBLICATIONS.

The only publication received from this station during the past fiscal year was a report on the work of the experiment station and laboratories of the Hawaiian Sugar Planters' Association.

IDAHO.

Agricultural Experiment Station of the University of Idaho, Moscow.

Department of the University of Idaho.

GOVERNING BOARD.

Board of Regents: Chas. L. Heitman (*President*), Rathdrum; Mrs. Wm. H. Ridenbaugh (*Vice-President*), Boise; George C. Parkinson (*Secretary*), Preston; Edward S. Sweet, Grangerille; J. H. McCarthy, Wallace; William L. Payne (*Treasurer*), Moscow.

STATION STAFF.

H. T. French, M. S., <i>Director; Agriculturist.</i>	C. N. Little, M. A., Ph. D., <i>Irrigation Engineer.</i>
L. F. Henderson, Ph. B., <i>Botanist.</i>	J. S. Burd, <i>Chemist.</i>
J. M. Aldrich, M. S., <i>Entomologist.</i>	W. G. Harrison, B. A., <i>Clerk.</i>
L. B. Jndson, B. S., <i>Horticulturist.</i>	Marion F. Wood, <i>Farm Foreman.</i>

GENERAL OUTLOOK.

Aside from the departments of the station in which changes of staff have occurred during the past year, the lines of work have been continued as formerly. Feeding experiments to determine the quality of meat and cost of production of crossbred as compared with pure-bred swine have been concluded, with results showing the Tamworth-Poland China cross to be superior to the pure-bred Poland China. The botanist of the station has succeeded in combating the mildew of gooseberries and grapes by spraying, and also in successfully treating apple scab and curly leaf in peaches. He is continuing considerable work with diseases and insects affecting fruits, and is also inaugurating some new work along these lines. The chemist has resumed the study of the gluten content of wheat to determine the milling quality of certain grades, and will take up the study of organic phosphorus in wheat, the composition of ripening fruits, alkali soils, and stock foods of the State. The entomologist is preparing a report on grasshopper and cricket depredations in the State, and the horticulturist has inaugurated a line of experiments in testing the effect of certain fertilizers in orchards in addition to the work already under way. The tests of novelties introduced by the seed trade in cooperation with the Bureau of Plant Industry of this Department have been continued, and tests of forage plants and imported cereals, including macaroni wheats, have been undertaken in cooperation with farmers in the eastern part of the State. The macaroni wheats have already made a good

showing in the State, even in the high altitudes where short seasons prevail.

The chemist severed his connection with the station June 30, 1903, and was succeeded by J. S. Burd of this Department. Considerable progress has been made during the year in separating the university and station work more clearly and in providing additional equipment for the station. A State appropriation of \$5,000 has been made for farm improvements, including \$3,000 for the purchase of improved live stock. The farm barn which was destroyed by wind has been rebuilt, and plans have been made for equipping a bacteriological laboratory for station work. The station is attracting much more interest throughout the State than ever before and is making considerable progress in the organization of its work on a more permanent basis, largely as the result of the appointment of a director as a separate administrative officer. The State appropriation of \$4,000 for farmers' institutes will relieve the station of any expenditures along this line, and the further appropriation for live stock and station improvements are encouraging as indicating the favor with which the work of the station is received throughout the State.

LINES OF WORK.

The principal lines of work conducted at the Idaho Station during the past year were as follows: Chemistry—experiments with sugar beets, studies of wheats and wheat soils, miscellaneous analytical work; botany—studies of plant diseases and their remedies, experiments with grasses and forage crops; field experiments—tests of various grasses and other forage crops for pasture and hay, experiments with cereals desirable for introduction; horticulture—cultural and variety tests of garden crops, fruits, and forest trees, pruning experiments and experiments with tomatoes; entomology—study of the codling moth in cooperation with entomologists of other northwestern stations, observations on phylloxera, and experiments with insecticides; feeding experiments—cattle, sheep, and swine.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	1,039.82
Farm products	1,408.61
Total	<hr/> 17,448.43

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 32-38 and the Annual Report for 1902. The bulletins include reports of investigations in feeding steers and lambs, analysis of stock foods, grasses, and clovers and how to grow them in Idaho, tomato culture, the codling moth, conditions of stock poisoning in Idaho, grasses and forage plants in Idaho, and meteorological records.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, Urbana.

Department of the University of Illinois.

GOVERNING BOARD.

Board of Trustees of the University: Governor Richard Yates, *Springfield*; James K. Dickirson, *Lawrenceville*; Alfred Bayliss, *Springfield*; Mrs. Alice A. Abbott, *1106 W. Illinois st., Urbana*; Frederic L. Hatch (*President*), *Spring Grove*; Augustus F. Nightingale, *159 La Salle st., Chicago*; Alexander McLean, *Macomb*; Samuel A. Bullard, *Springfield*; Mrs. Carrie T. Alexander, *Bellerille*; Wm. B. McKinley, *Champaign*; L. H. Kerriek, *Bloomington*; Laura B. Evans, *Taylorville*; Wm. L. Pillsbury (*Secretary*), *Urbana*; E. G. Keith (*Treasurer*), *Chicago*.

STATION STAFF.

Eugene Davenport, M. Agr., <i>Director</i> .	J. W. Hart, <i>Chief Assistant in Dairy Manufactures.</i>
T. J. Burrill, Ph. D., <i>Botanist.</i>	H. A. Hopper, B. S. A., <i>Assistant in Dairy Husbandry.</i>
C. G. Hopkins, Ph. D., <i>Chief in Agronomy, Chemist.</i>	C. C. Hayden, B. S. A., <i>Assistant in Dairy Husbandry.</i>
J. C. Blair, <i>Chief in Horticulture.</i>	E. S. Good, B. S., <i>Assistant in Animal Husbandry.</i>
H. W. Mumford, B. S., <i>Chief in Animal Husbandry.</i>	Carl E. Lee, B. S., <i>Assistant in Dairy Husbandry.</i>
W. J. Fraser, M. S., <i>Chief in Dairy Husbandry.</i>	J. T. Barrett, B. S., <i>Assistant Botanist.</i>
C. F. Hottes, Ph. D., <i>Chief in Vegetable Physiology.</i>	J. H. Pettit, Ph. B., <i>Assistant in Soil Analyses.</i>
L. H. Smith, B. S., <i>Chief Assistant in Chemistry and Plant Breeding.</i>	E. M. East, B. S., <i>Assistant in Chemistry.</i>
A. D. Shamel, B. S., <i>Chief Assistant in Farm Crops.</i>	W. F. Pate, B. S., <i>Assistant in Chemistry.</i>
J. W. Lloyd, B. S. A., <i>Chief Assistant in Horticulture.</i>	R. C. Obrecht, B. S. A., <i>Assistant in Horse Investigations.</i>
A. J. Glover, B. Agr., <i>Chief Assistant in Field Investigations.</i>	C. Willis, B. S., <i>Assistant in Soil Physics.</i>
J. G. Mosier, B. S., <i>Chief Assistant in Soil Physics.</i>	I. O. Schaub, B. S., <i>Assistant in Chemistry.</i>
C. S. Crandall, M. S., <i>Chief Assistant in Pomology.</i>	C. A. Schroeder, M. S., <i>Assistant in Chemistry.</i>
	William Dietrich, B. S. A., <i>Assistant in Swine Husbandry.</i>
	Kate McIntyre, <i>Secretary.</i>

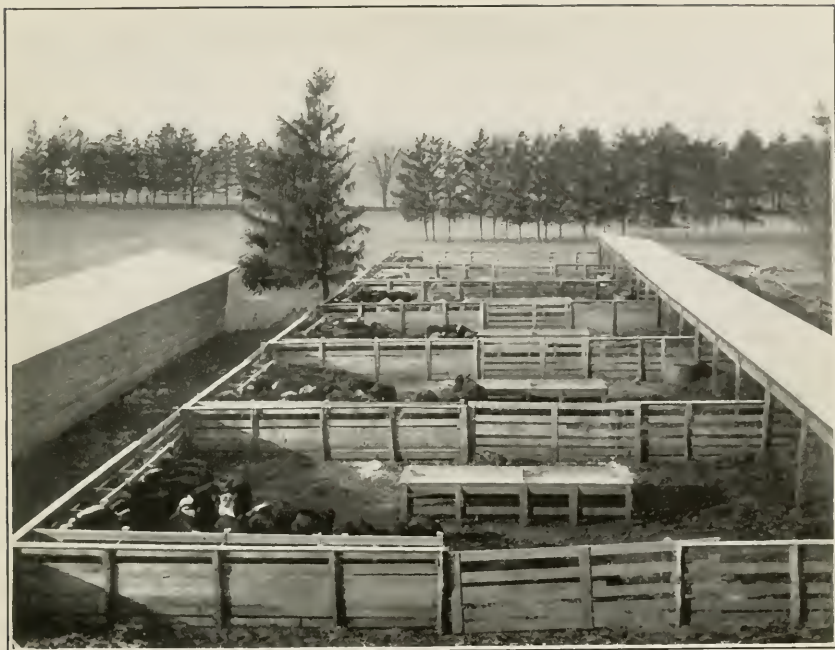


FIG. 1.—ILLINOIS STATION—FEEDING SHEDS AND PENS.



FIG. 2.—IOWA STATION—COOPERATIVE FEEDING EXPERIMENTS AT ODEBOLT.

GENERAL OUTLOOK.

The large funds at the disposal of the Illinois Station during the past two years have enabled it to prosecute vigorously the work already in hand and to take up many additional lines. Experiments with alfalfa show here as elsewhere a general failure of this crop where the specific alfalfa bacterium is absent. In some locations the soils have been found so acid as to impair if not altogether prevent the development of root tubercles on legumes. Other soils covering large areas have been found notably deficient in phosphorus, and farmers in these localities are now profiting greatly through the application of phosphorus, lime, and the use of leguminous crops. Recent experiments to determine whether large production of milk from a given amount of feed was due to more perfect digestion on the part of some cows or greater ability of these animals to produce milk from the digested feed indicate the latter to be the cause of the larger milk production. There is apparently very little difference in the power of individual cows when in good health to digest feed.

The station has recently inaugurated investigations to determine the cost of producing beef from birth to finish (Pl. II, fig. 1), and to compare the relative value of the shed and the stable for housing cows. Field work among creameries and cheese factories throughout the State has been undertaken, and the cooperative experiments with farmers have been continued. The station has also begun field work in the dairy districts of northern Illinois for the purpose of studying and improving dairy methods. The objects of this work, as well as of field work with spraying mixtures and soil inoculations, are to do for the farmer what he can not do for himself, or else lead him to see the necessity for better methods. Cooperation with this Department in testing novelties, making a soil survey, and studying the available plant food in soils has been continued, and an investigation of insects affecting wheat has been undertaken in cooperation with the Division of Entomology.

The legislature of Illinois at its last session nearly doubled the State appropriations for the college and station, giving \$50,000 to the college of agriculture and \$85,000 to the station, which, with the Hatch fund, makes a total of \$100,000 annually for investigations. The State funds for experimental work are apportioned as follows: Live-stock investigations and soil work each \$25,000, dairy work \$15,000, corn improvement and breeding and horticultural investigations each \$10,000. These liberal appropriations were secured largely through the aid of the agricultural associations of the State, the presidents of which form an advisory committee to act with the director of the station in determining the lines of work to be undertaken. The extension

of the work of the station over such large areas and on such a large scale has necessitated the creation of nine new positions on the station staff.

The college of agriculture, with more generous State support than heretofore, is enabled to continue and extend its cooperative enterprises and to inaugurate some new lines of work among school children in the rural districts by which these children are brought into sympathetic relation with the college and are given some instruction which will enable them to better understand the literature issued by the college of agriculture and other similar institutions. A portion of the \$50,000 appropriated by the last legislature will be used in the erection of farm buildings, which will be of direct benefit to the station. These additional funds have also enabled the college to make a more satisfactory cooperative arrangement with this Office for the investigation of problems in human nutrition.

LINES OF WORK.

The principal lines of work conducted at the Illinois Station during the past year were as follows: Chemistry—studies of the chemical composition of corn; bacteriology; pot and field experiments—pot experiments with type soils from different parts of the State, studies on management of soils conducted on type soils in fifteen or sixteen different regions, inoculation experiments with alfalfa, experiments with sugar beets; horticulture—experiments in orchard management, renovation of orchards, cold-storage investigations, experiments with garden vegetables; forestry; plant breeding—experiments in breeding and selecting corn to change the protein, oil, and starch contents; animal husbandry—studies of dairy conditions in different parts of the State, study of methods of grading beef cattle in Chicago markets, experiments on cost of beef production and on methods of housing cattle, feeding experiments with pigs; diseases of plants—study of bitter rot and other rots of apples, apple scabs and cankers; diseases of animals; entomology; dairying, and extension work in orchard management; dairy methods and the use of soil inoculations.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000. 00
State appropriation	54,000. 00
Fees	630. 00
Farm products	945. 02
Balance from previous year	331. 61
Total	70,906. 63

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 73-84, Circulars 38-59 and 61-69, and the Annual Report for 1902. The different subjects treated in the bulletins areas follows: Comparison of silage and shock corn for wintering calves intended for beef production; standard milk and cream; standardization of milk and cream; alfalfa on Illinois soils; bitter rot of apples; market classes and grades of cattle with suggestions for interpreting market quotations; the corn billbugs of Illinois; methods and results of field insecticide work against the San José scale, 1899-1902; forcing tomatoes; methods of corn breeding; feeds supplementary to corn for fattening steers, and dairy conditions and suggestions for their improvement. The circulars include brief information on a large number of topics which will subsequently be taken up more at length in regular bulletins.

INDIANA.

Agricultural Experiment Station of Indiana, Lafayette.

Department of Purdue University.

GOVERNING BOARD.

Board of Trustees: William V. Stuart (*President*), Lafayette; E. A. Ellsworth (*Secretary*), Lafayette; J. M. Fowler (*Treasurer*), Lafayette; William A. Banks, Laporte; James M. Barrett, Fort Wayne; David E. Beem (*Vice-President*), Spencer; Chas. Downing, Greenfield; Sylvester Johnson, Irvington; Chas. Major, Shelbyville; C. B. Stemen, Fort Wayne; J. H. Van Natta, Lafayette.

STATION STAFF.

Arthur Goss, M. S., A. C., <i>Director</i> ;	J. H. Skinner, B. S., <i>Animal Husbandman</i> .
<i>Chemist</i> .	A. T. Wiancko, B. S. A., <i>In charge of</i>
W. C. Latta, M. S., <i>Agriculturist</i> .	<i>Field Experiments</i> .
James Troop, M. S., <i>Horticulturist</i> .	W. J. Jones, M. S., A. C., <i>Assistant</i>
J. C. Arthur, D. Sc., <i>Botanist</i> .	<i>Chemist</i> .
A. W. Bitting, D. V. M., <i>Veterinarian</i> .	H. E. Van Norman, B. S., <i>Dairying</i> .
M. L. Fisher, B. S., <i>Assistant Agriculturist</i> .	

GENERAL OUTLOOK.

The affairs of the Indiana Station have been in rather unstable condition, owing to changes in the office of director, but a permanent director is now in charge. In most instances the old lines of work have been continued, but some new work has been started. This includes a chemical soil survey of the State, a chemical study of corn at different stages of growth, supplementary irrigation on a small scale, diseases of hogs, rust diseases of plants, vitality and germinating power of seeds, corn breeding, inoculation of leguminous plants, culture experiments with alfalfa, a study of moisture content of butter

and methods of pasteurizing cream for butter making. The studies on the influence of climate on forest-tree seedlings, in cooperation with the Bureau of Forestry of this Department, have been completed. The station is cooperating with the Bureau of Plant Industry in tests of novelties introduced by the seed trade, and with the Bureau of Chemistry in the investigation of the gluten content of wheat, sugar-beet investigations, and the influence of environment on the sugar content of muskmelons.

The new agricultural building of the college and station is now occupied and furnishes excellent quarters for the agriculturist, horticulturist, animal husbandman, dairyman, and veterinarian of the station. The station suffered considerable loss by the destruction of its cattle barn by lightning, July 10, 1903. The loss was about \$4,800. A temporary structure has been erected with the understanding that next year a barn costing about \$15,000 will be constructed.

The university, with which the station is connected, is now receiving more liberal treatment by the State. The last legislature doubled the tax levy, so that the university now receives a revenue of \$140,000 annually from this source. There is a disposition on the part of the university officers to strengthen the agricultural work, and the station is sharing somewhat in the forward movement. It is still greatly in need of additional funds, which will make possible a general strengthening of its research work. Considering the large and varied agricultural interests of Indiana, this station could profitably use a much larger fund in the extension of its present lines of work and in entering other important fields which it is now compelled to neglect.

LINES OF WORK.

The principal lines of work conducted at the Indiana Station during the past year were as follows: Chemistry—studies of sugar beets, the nitrogen-free extract of feeding stuffs, the improvement of muck soils of the State, fertilizer experiments with tomatoes, study of chemical composition of corn at different stages of growth, corn breeding; pot and field experiments—culture and fertilizer experiments with cereals and forage crops, rotations, pot experiments with legumes and cereals to test the efficiency of soil inoculation; horticulture—cross fertilization of apples, variety tests of fruits and vegetables, surface and sub-irrigation for vegetables in hothouses, influence of climate on forest-tree seedlings; feeding experiments—comparison of tankage and other feeds for swine, feeding dairy cows; diseases of plants and animals—studies of diseases of cattle, sheep and pigs, treatment of oats and wheat for smut, study of edible fungi, and rusts of sedges; dairying—study of moisture content of butter and of methods of pasteurizing cream for butter making.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products, including balance from 1902.....	2,315.92
Improvement fund.....	1,484.63
Total.....	18,800.55

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 93 and 94 and the Annual Report for 1902. Bulletin 93 is on the influence of condimental stock food in fattening swine, and Bulletin 94 on diseases of sheep.

IOWA.

Iowa Agricultural Experiment Station, Ames.

Department of Iowa State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Trustees: Governor A. B. Cummins, *Des Moines*; R. C. Barrett (*Superintendent of Public Instruction*), *Des Moines*; W. O. McElroy, *Newton*; W. A. Helsell (*Financial Secretary*), *Odebolt*; Herman Knapp (*Treasurer*), *Ames*; W. K. Boardman, *Nevada*; E. W. Stanton (*Secretary*), *Ames*; E. A. Alexander, *Clarion*; C. L. Gabrilson, *New Hampton*; J. B. Hungerford (*Chairman*), *Carroll*; W. R. Moninger, *Marshalltown*; Jas. H. Wilson, *Adair*; S. H. Watkins, *Libertyville*; C. S. Barclay, *West Liberty*; W. B. Penick, *Chariton*; John F. Cavell (*Custodian*), *Ames*.

STATION STAFF.

C. F. Curtiss, M. S. A., <i>Director; Agriculturist; Dean.</i>	E. E. Little, M. S. A., <i>Assistant Horticulturist.</i>
J. B. Weems, B. S., Ph. D., <i>Agricultural Chemist.</i>	E. C. Myers, B. S. A., <i>Assistant Agricultural Chemist.</i>
L. H. Pammel, B. Agr., M. S., Ph. D., <i>Botanist.</i>	C. Larson, B. S. A., <i>Assistant in Dairying.</i>
H. E. Summers, B. S., <i>Entomologist.</i>	W. H. Olin, M. S. A., <i>Assistant in Farm Crops.</i>
W. J. Kennedy, B. S. A., <i>Vice-Director; Animal Husbandman.</i>	T. S. Hunt, <i>Assistant Agronomist.</i>
G. L. McKay, <i>Dairying.</i>	Wayne Dinsmore, <i>Assistant Animal Husbandman.</i>
P. G. Holden, M. S., B. Ped., <i>Agronomist.</i>	W. J. Rutherford, B. S. A., <i>Assistant Animal Husbandman.</i>
W. H. Stevensen, B. A., <i>Soils.</i>	G. E. Stayner, <i>Assistant Agronomist.</i>
F. W. Bouska, B. S. A., <i>Dairy Bacteriologist.</i>	R. E. Buchanan, <i>Assistant Botanist.</i>
A. T. Erwin, M. S., <i>Assistant Horticulturist.</i>	J. E. Guthrie, M. S., <i>Assistant Entomologist.</i>
	C. W. Gay, D. V. M., <i>Veterinarian.</i>
	Miss C. M. King, <i>Artist.</i>

GENERAL OUTLOOK.

The Iowa Station has continued important investigations in animal husbandry supplemented by cooperative feeding experiments on a large scale on the Brookmont Farm at Odebolt. During the past winter 500 steers and 500 hogs were fed (Pl. II, fig. 2). In these experiments the stock-food companies declined to cooperate, and the experiment was modified so as to test the relative value of Southern cattle, as compared with native range and high-bred cattle and the effects of different amounts of grain, different kinds of roughage, etc. There were also corn-breeding experiments and cultural experiments on the Brookmont Farm, and all of this work was under the supervision of station experts. The agronomic work of the station has been greatly broadened and now includes extensive experiments in corn breeding, corn improvement, and the testing of promising varieties of cereals and grasses. In the division of horticulture the work with hardy fruits and ornamental plants has been continued and special experiments in the breeding of roses adapted to Iowa conditions have been undertaken. In the dairy division special investigations in reference to the water content of butter are being conducted. In addition to the cooperative enterprises conducted at Odebolt, the station is cooperating with farmers in other parts of the State in the improvement of corn and other grains, with the Bureau of Animal Industry of this Department in investigations in breeding sheep to produce a type better suited to range conditions, with the Bureau of Plant Industry in cereal investigations and tests of novelties introduced by the seed trade, and with the Bureau of Chemistry in studying the available plant food in soils and in sugar-beet investigations.

The Iowa college has completely reorganized its courses of study and now offers four full four-year courses in agriculture specialized along the lines of animal husbandry, agronomy, horticulture, and dairying. The agronomy work has been greatly broadened and strengthened during the year, and a chair of farm mechanics has been established in connection with it, to which C. J. Zintheo, lately of the North Dakota Agricultural College, has been elected. For the accommodation of the work in farm mechanics a fireproof addition to the agricultural building, 60 by 100 feet, two stories in height, with two balconies, has been erected. A new judging pavilion for animal husbandry and agronomy has recently been completed at a cost of about \$15,000. (See *Progress in Agricultural Education*, p. 600). This building is 65 feet in diameter, two stories high, octagonal in form, and substantially built of brick, with a slate roof. About 4,000 square feet of additional greenhouse room has been provided for the departments of horticulture, agronomy, and entomology. Rev. A. B. Storms, of Des Moines, has recently been elected to the presidency of the college

to succeed W. M. Beardshear, deceased. The professor of horticulture of the college and horticulturist of the station has resigned to become dean of the college of agriculture of Ohio State University. The staff of the station has been strengthened by the addition of several assistants.

The Iowa Station is growing rapidly and is strengthening its work by the organization of a strong staff and the addition of substantial and convenient buildings and other equipment for purposes of investigation. The State is making liberal provision for improving the equipment of the station, but the demand for investigations on a large scale is far greater than the station can meet with its present funds. Iowa is one of the greatest agricultural States in the Union, and problems requiring investigation are so numerous and important that greatly increased funds should be provided for the station.

LINES OF WORK.

The principal lines of work conducted at the Iowa Station during the past year were as follows: Chemistry—studies of adulterants of dairy products, examination of grasses, soils, waters, and dairy products; botany—study of grasses of the State, forestry problems, etc.; field experiments—cultural and breeding experiments with corn, wheat, and other cereals, flax, legumes, sorghum, teosinte, millet, Kafir corn, sugar beets, carrots, and potatoes; horticulture—crossing of fruits, tests of cover crops, cross pollination of apples in different parts of the State, culture and variety tests of celery, tests of ornamentals, top-working of apples on crab stocks, diseases of plants; animal husbandry—feeding experiments with cattle and sheep in earload lots, and with horses and swine, comparison of proprietary feeds, gluten feed and meal, and corn; breeding range sheep and horses; entomology, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
State appropriation.....	10,000.00
Individuals.....	200.00
Fees.....	51.00
Farm products.....	4,752.91
Miscellaneous.....	824.24
Total.....	<u>30,828.15</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 61 and 65-68 and a spraying calendar for 1903. The subjects treated in the bulletins were the chemical composition of food preservatives, the results of feeding experiments with cattle and swine, miscellaneous notes on fungus diseases of plants, the Canada thistle and dandelion, a few of the common fleshy fungi of Ames, solutions for testing cream, selecting and preparing seed corn, and a catalogue of fruits growing on the experimental grounds of the Iowa Experiment Station.

KANSAS.

Kansas Agricultural Experiment Station, *Manhattan*.

Department of Kansas State Agricultural College.

GOVERNING BOARD.

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STATION STAFF.

J. T. Willard, M. S., *Director; Chemist*.
 E. A. Popenoe, M. A., *Entomologist*.
 H. F. Roberts, M. S., *Botanist*.
 N. S. Mayo, M. S., D. V. S., *Veterinarian*.
 Albert Dickens, M. S., *Horticulturist*.
 A. M. Ten Eyck, B. Agr., *Agriculturist*.
 Oscar Erf, B. S. Agr., *Dairying, Animal Husbandmen*.
 Lorena E. Clemons, B. S., *Secretary*.
 V. M. Shoosmith, B. S., *Assistant in Feeding and Field Work*.
 G. A. Dean, B. S., *Assistant Entomologist*.
 L. F. Paull, M. A., *Assistant Botanist*.

C. L. Barnes, D. V. M., *Assistant in Veterinary Department*.
 R. H. Shaw, B. S., *Assistant Chemist*.
 R. E. Eastman, M. S., *Assistant Horticulturist*.
 G. C. Wheeler, B. S., *Assistant in Feeding Experiments*.
 Alice M. Melton, B. S., *Clerk to Director*.
 J. G. Haney, M. S., *Superintendent of Fort Hays Branch Experiment Station, Hays*.
 O. H. Elling, *Foreman of Fort Hays Branch Experiment Station*.

GENERAL OUTLOOK.

The work of the Kansas Station has been continued during the past year along much the same lines as formerly. The experiments in commercial orcharding were very much deranged by the destruction of a large part of the orchard and vineyard by the floods last spring and have been discontinued. The farm department has largely increased its experiments with farm crops, including variety work with all the common cereals, grasses, and forage crops, and rotation experiments with wheat and corn. There are now about 450 plats under experiment. The horticulturist in connection with his efforts to improve the native fruits is selecting persimmons for the purpose of securing seedless varieties of larger size and better quality than the

wild fruit. Much the same work is being attempted with the papaw. Quite extensive feeding experiments have been made with calves, cows, and steers in testing various corn and Katir corn feeds, skim milk, buttermilk, alfalfa, and silage. Experiments are also in progress to determine the best varieties of grasses for permanent pasture, of annuals for spring and fall pasture, and of crops for silage. The station is cooperating with the Bureau of Animal Industry of this Department in studying the conditions and limitations incident to the extension of the dairy industry in the short-grass country between the Mississippi River and the Rocky Mountains, with the Bureau of Plant Industry in testing novelties introduced by the seed trade and cereal investigations, with the Bureau of Chemistry in studying the available plant food in soils, and with this Office in irrigation investigations.

A new physical science hall has been completed at a cost of \$57,000, exclusive of the heating plant and equipment. This is a fine building, and gives excellent accommodation for the chemical work of the station. The college has commenced the erection of a commodious auditorium with an appropriation of \$40,000 made by the last legislature, and a dairy building to cost \$15,000, which was provided by the same appropriation. The total amount appropriated at that time for buildings and the maintenance of the college was \$240,260, to extend over the biennial period. This includes \$5,000 for an addition to the shops, \$10,500 for additional land, \$10,000 for a water plant, \$5,000 per annum for animal husbandry, \$2,000 per annum for agronomy, \$1,500 per annum for horticulture, and \$2,000 per annum for farmers' institutes. A number of changes have been made in the station staff during the year. The dairy husbandman, who has just recently resigned from the station, was made animal husbandman, and E. H. Webster, assistant in dairying, was made dairy husbandman. The latter has now resigned to enter the Dairy Division of this Department, and is succeeded by Oscar Erf, lately of the University of Illinois, who is also made animal husbandman. There have been changes also in the veterinary and chemistry departments.

The work at the Fort Hays Branch Station has been largely of a pioneer character, such crops being grown as could be planted on sod. An excellent crop of wheat was harvested, and tests of macaroni wheat, barley, and a large variety of grasses and forage crops were made. An orchard of 300 trees and a vineyard of 500 vines have made good growth. The legislature appropriated a total of \$32,500 for the support of this station during the biennial period, including \$1,000 for irrigation investigations in cooperation with this Office. The experiments with cereals, grasses, and forage plants in cooperation with the Bureau of Plant Industry of this Department are conducted at the Fort Hays Station and near Halstead, in Harvey County.

The Kansas Station is doing considerable useful work, but needs more generous support in order to make its investigations commensurate with the agricultural interests of the State. With the rapid growth of the college with which the station is connected, and increased interest in the farmers' institutes in the State, the duties of the men on the station staff have become too numerous and severe to permit them to give as much time and energy to the station work as is most desirable. This could be remedied if the institution were more liberally supplied with funds, so that the station staff could be organized primarily with reference to the work of investigating agricultural problems.

LINES OF WORK.

The principal lines of work conducted at the Kansas Station during the past year were as follows: Soils—moisture determinations, bacteriological investigations; horticulture—interpollinating apples, selecting and improving native fruits; plant breeding—to increase the protein content of corn; field experiments—growing drought-resistant crops, variety tests of grasses; feeding and digestion experiments—maintenance ration, experiments with wheat and wheat straw, feeding calves; diseases of animals—infectious sore mouth of cattle, cattle distemper, blackleg, poisoning from weeds; entomology; dairying; and extermination of prairie dogs and gophers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
State appropriation.....	"3,000.00
Farm products.....	5,511.61
Balance on hand July 1, 1902.....	1,743.18
Total.....	25,254.79

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1902 and Bulletins 110–116 on grapes, quality in beef, fattening steers without hogs to follow, baby beef, growing alfalfa in Kansas, the exact calculation of balanced rations, destroying prairie dogs and pocket gophers. The station also publishes a large number of press bulletins which from time to time are collated and reprinted under a regular bulletin number.

a For Fort Hays Substation.

KENTUCKY.

Kentucky Agricultural Experiment Station, *Lexington*.

Department of the Agricultural and Mechanical College of Kentucky.

GOVERNING BOARD.

Board of Control: George B. Kinkead (*Chairman*), *Lexington*; William C. Bell, *Harrodsburg*; J. K. Patterson, *Lexington*; M. A. Scovell (*Secretary*), *Lexington*; D. F. Frazee, *Lexington*; Richard C. Stoll, *Lexington*.

STATION STAFF.

M. A. Scovell, M. S., <i>Director; Chemist.</i>	D. W. May, M. S., <i>Animal Husbandman.</i>
A. M. Peter, M. S., <i>Chemist.</i>	J. D. Turner, B. PED., <i>Secretary to Director.</i>
H. E. Curtis, M. S., <i>Chemist.</i>	R. M. Allen, B. A., <i>Secretary of Food Division.</i>
Harrison Garman, <i>Entomologist, Botanist.</i>	Mary L. Didlake, M. S., <i>Assistant Entomologist and Botanist.</i>
J. N. Harper, B. S., <i>Agriculturist.</i>	W. G. Campbell, B. A., <i>Assistant in Co-operative Experiments.</i>
J. O. La Bach, M. S., <i>Chemist of Food Division.</i>	G. N. Keller, <i>Assistant Entomologist and Botanist.</i>
W. H. Schertlin, B. S., <i>Chemist.</i>	
J. W. Nutter, <i>Assistant Dairyman.</i>	
O. M. Shedd, B. S., <i>Assistant Chemist.</i>	
S. D. Averitt, M. S., <i>Assistant Chemist.</i>	

GENERAL OUTLOOK.

The Kentucky Station is at present giving more attention to increasing its facilities than to enlarging the scope of its investigations. However, there has been considerable development of work in the line of beef production, and a study of economic rations under local conditions for dairy cattle is in progress. In an experiment in fattening beef cattle just brought to a successful close, dried distillery grains proved to be a better feed with corn than some of the by-products usually fed. Plans are now under way to cooperate with farmers feeding large numbers of cattle at the distilleries to determine the advisability of feeding dried grains or slop. Some problems in horse breeding are under investigation, also the source and system of supplying water for stock and for irrigation. For two years White Burley tobacco has been grown under canvas for the purpose of securing a finer quality of cigarette wrapper, and during the past season a tobacco company has also taken up the work, growing two-acre lots under shade in five different counties of the State.

The station continues to cooperate with the Bureau of Plant Industry of this Department in studying methods of establishing and maintaining permanent pastures, the influence of origin of red-clover seed on yield of crop, rotation of crops, farm management, and tests of novelties introduced by the seed trade, and with the Bureau of Chemistry on sugar-beet investigations, investigations of the gluten content of wheat, and studies of available plant food in soils and of the influence of environment on the sugar content of muskmelons. The station is

doing a large amount of inspection work, and its staff renders assistance to the State commissioner of agriculture in farmers' institutes and to the State board of health in chemical and bacteriological analyses. The inspection work includes fertilizers, foods, feeding stuffs, and nursery products.

A dairy barn, costing \$8,500, and some smaller buildings have recently been completed. The barn (Pl. III, fig. 1) contains an office, veterinary room, herdsman's room, bathroom, stalls for 30 milch cows (Pl. III, fig. 2), box stalls for bulls and calves, and the necessary storage space for feed, forage, and bedding. A new station building, costing \$20,000, is under construction. It is being built of pressed brick and will be wholly devoted to the offices and laboratories of the various divisions of the station. The new farm is being in part laid out for experimental work this season for the first time. The Kentucky Station now has a liberal income, which is devoted strictly to station uses, and a staff which is almost entirely relieved from college duties. Under such conditions it is rapidly securing such facilities as will enable it in the near future to greatly broaden its work of investigation and thus increase its usefulness to the agriculture of the State.

LINES OF WORK.

The principal lines of work conducted by the Kentucky Station during the past year were as follows: Chemistry; soils; analyses of fertilizers, foods, and feeding stuffs; inspection of orchards and nurseries; field experiments—hemp, tobacco, cereals, legumes, fertilizers; horticulture; plant breeding—wheat and sorghum; breeding of animals; pig feeding; diseases of plants—broom rape of hemp and tomato rot; entomology—the Hessian fly, apiculture; dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000. 00
State appropriation, including balance from previous year..	5,712. 99
Fees, including balance from previous year	35,177. 36
Farm products, including balance from previous year.....	9,216. 50
Miscellaneous, including balance from previous year	619. 81
Total	<hr/> 65,726. 66

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 98-106. These cover the results of the study of forage plants for Kentucky; varieties of oats and their feeding value; inspec-



FIG. 1.—KENTUCKY STATION—DAIRY BARN.



FIG. 2.—KENTUCKY STATION—INTERIOR OF DAIRY BARN.

tion and analyses of foods; the value of certain grains and by-products as feed for pigs; commercial fertilizers; the Hessian fly—life history and remedies; broom rape of hemp and method of combating the same, and the feeding of dairy cows.

LOUISIANA.

No. 1. Sugar Experiment Station, Audubon Park, New Orleans.

No. 2. State Experiment Station, Baton Rouge.

No. 3. North Louisiana Experiment Station, Calhoun.

Department of Louisiana State University and Agricultural and Mechanical College.

GOVERNING BOARD.

State Board of Agriculture and Immigration: Governor W. W. Heard, *Baton Rouge*; Henry L. Fuqua (*Vice-President*), *Baton Rouge*; J. G. Lee (*Commissioner*), *Baton Rouge*; Thos. D. Boyd (*President of State University*), *Baton Rouge*; Wm. C. Stubbs (*Director of State Experiment Station*), *Baton Rouge*; John Dymond, *Belair*; Emile Rost, *St. Rose*; A. V. Eastman, *Lake Charles*; E. T. Sellers, *Walnut Lane*; Chas. Schuler, *Keatchie*; H. P. McClendon, *Amite*.

STATION STAFF.

Sugar Experiment Station, *Audubon Park, New Orleans.*

W. C. Stubbs, PH. D., <i>Director.</i>	C. A. Browne, jr., PH. D., <i>Chemist.</i>
R. E. Blouin, M. S., <i>Assistant Director;</i> <i>Chemist.</i>	G. D. Harris, M. S., M. A., <i>Geologist.</i>
P. L. Hutchinson, B. S., <i>Chemist.</i>	G. B. Taylor, B. S., <i>Assistant Chemist.</i>
E. F. Lines, <i>Assistant Geologist.</i>	George Chiquelin, <i>Sugar Maker.</i>
Robert Glenk, PH. G., B. S., <i>Chemist.</i>	D. Williams, <i>Farm Manager.</i>
	J. K. McHugh, <i>Secretary, Stenographer.</i>

State Experiment Station, *Baton Rouge.*

W. C. Stubbs, M. A., PH. D., <i>Director.</i>	C. E. Coates, jr., PH. D., <i>Chemist.</i>
W. R. Dodson, B. A., B. S., <i>Assistant</i> <i>Director.</i>	H. Skolfield, <i>Treasurer.</i>
W. H. Dalrymple, M. R. C. V. S., <i>Vet-</i> <i>erinarian.</i>	H. A. Morgan, B. S. A., <i>Entomologist.</i>
	F. H. Burnette, <i>Horticulturist.</i>
	B. H. Atkinson, <i>Farm Manager.</i>

North Louisiana Experiment Station, *Calhoun.*

W. C. Stubbs, M. A., PH. D., <i>Director.</i>	E. J. Watson, <i>Horticulturist.</i>
D. N. Barrow, B. S., <i>Assistant Director.</i>	Travis McClendon, <i>Dairyman, Poultryman.</i>
Simon Bann, B. S., <i>Chemist.</i>	L. H. Peevy, <i>Farm Manager.</i>

GENERAL OUTLOOK.

The work of the Louisiana stations follows very closely the lines heretofore pursued, special attention being given to beef production, using home-grown forage plants and the by-products of rice, cotton seed, and sugar cane. A very thorough study of the chemical composition, digestibility, and feeding value of rice by-products is being made. The rotation experiments, tests of forage plants and other field crops, and the improvement of cotton, sugar cane, and potatoes are being continued. The field experiments at Baton Rouge suf-

fered greatly from drought this year. At Audubon Park injury was prevented only by irrigation. This station and the one at Calhoun are equipped for irrigation. In experiments at Calhoun on light, permeable soils, extending over three years, there has been an average increase due to irrigation "of 11.5 tons of cane, 10.9 bushels of corn, 1,309 pounds of stover, 8 tons of sorghum, 2.68 pounds of cotton, 1.87 pounds of tobacco, 12 bushels of peas, and 4,203 pounds of watermelon. At the ordinary values of these crops there has been an average money gain by irrigation of \$39.20 on cane, \$6.91 on corn, \$8 on sorghum, \$8.55 on cotton, \$9.35 on tobacco, \$18 on peas, and \$10 on watermelons. There has been an average profit on all crops of \$14, despite the fact that nearly sufficient moisture fell in 1900 for the needs of the growing crops." At Audubon Park, on the other hand, with heavier rainfall and more compact soils, the average for a series of years in favor of irrigation has been small, and in many cases irrigation has been injurious.

The veterinarian is continuing investigations on stomach worms, a nodular disease of the intestines of sheep, and Texas fever. He is testing a system by which he hopes to be able to rear healthy lambs from dams affected with stomach worms or the nodular disease. In all this work he has the effective cooperation of the entomologist. The latter, from a study of the life history and habits of the cattle tick, is working out a system of rotation of fields for tick-infested cattle, which promises an effective means of ridding cattle of ticks and controlling the disease. He is also cooperating with the Division of Entomology of this Department in studying horseflies, the Mexican cotton-boll weevil, and mosquitoes. The stations are also cooperating with the Bureau of Soils in a soil survey. The geological survey, with a State appropriation of \$5,000, has been continued. The director is preparing a State exhibit for the Louisiana Purchase Exposition, for which an appropriation of \$100,000 has been made. The new library, provided for by private bequest, and the dormitory and mechanical arts buildings, for which the State legislature made appropriations, are approaching completion.

The Louisiana stations continue to exert a strong influence for the improvement of agricultural practice in the State. The work of the veterinarian in immunizing cattle against Texas fever is doing much to encourage the introduction of improved beef and dairy animals. The opportunity for development along these lines is large, as the stations have shown that abundant forage is easily produced, and the by-products of the cotton, rice, and sugar industries furnish a large amount of cheap concentrated feed. The work with forage plants has been very comprehensive and successful and has met with so much favor that there has been a large demand for bulletins on this subject. As in former years, considerable attention has been given by mem-

bers of the staff to work in farmers' institutes. There is need of additional funds to investigate problems which the rapidly growing resources of the State are bringing up—problems in animal husbandry, in irrigation for rice and the utilization of rice products, in sugar production, and in cotton growing and the development of means for resisting the advances of the Mexican cotton-boll weevil.

LINES OF WORK.

The principal lines of work conducted at the Louisiana stations during the past year were as follows:

SUGAR STATION.—Chemistry; bacteriology; soils and soil physics; field experiments—tests of fodder plants and varieties of cane; horticulture—tests of home-grown *v.* northern-grown seeds; sugar making; drainage; irrigation.

STATE STATION.—Geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments—forage crops, legumes, rotations, varieties of cotton and sugar cane; horticulture; animal husbandry—breeding and feeding for beef production; diseases of animals—inoculation for Texas fever, study of the nodular disease of the intestines of sheep, anthrax, glanders, etc., and entomology.

NORTHERN STATION.—Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising, and dairying.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation.....	\$15,000. 00
State appropriation.....	20, 000. 00
Fees.....	10, 000. 00
Farm products.....	1, 869. 30
Miscellaneous, including balance from previous year.....	11, 218. 62
Total.....	58, 087. 92

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of these stations received during the past fiscal year were the Annual Reports for 1901 and 1902 and Bulletins 66-74 on experiments in cultivating sugar cane, broom corn, home-grown *v.* purchased seed, pecans, cane borer, a report on the geology of Louisiana, analysis of commercial fertilizers and Paris green, sheep, forage crops, grasses, alfalfa, clovers, etc.

MAINE.

Maine Agricultural Experiment Station, Orono.

Department of University of Maine.

GOVERNING BOARD.

Station Council: George E. Fellows (*President*), Orono; Chas. D. Woods (*Secretary*), Orono; John A. Roberts, Norway; Chas. L. Jones, Corinna; Albert J. Durgin, Orono; A. W. Gilman, Fowcroft; Eugene H. Libby, Auburn; Chas. S. Pope, Manchester; James M. Bartlett, Orono; L. H. Merrill, Orono; F. L. Russell, Orono; W. M. Munson, Orono; G. M. Gowell, Orono.

STATION STAFF.

Chas. D. Woods, B. S., <i>Director</i> .	Edith M. Patch, B. A., <i>Entomologist</i> .
J. M. Bartlett, M. S., <i>Chemist</i> .	G. A. Drew, Ph. D., <i>Zoologist</i> .
L. H. Merrill, B. S., <i>Chemist</i> .	H. H. Hanson, B. S., <i>Assistant Chemist</i> .
F. L. Russell, B. S., V. S., <i>Veterinarian</i> .	S. C. Dinsmore, <i>Assistant Chemist</i> .
W. M. Munson, Ph. D., <i>Horticulturist</i> .	M. B. Cummings, B. S., <i>Assistant Horticulturist</i> .
G. M. Gowell, M. S., <i>Stock Breeding, Poultry</i> .	Annie M. Snow, <i>Stenographer</i> .

GENERAL OUTLOOK.

The work of the Maine Station during the past year has been largely a continuation of investigations started in former years. The digestion investigations with lumbermen, in cooperation with this Office, have been continued, and the most remarkable feature noted has been the very large dietaries of these men. Digestion investigations with steers have included studies upon the effect of different amounts of protein of the same kind upon digestibility, and the comparative digestibility of heavy and light rations. An experiment is in progress to show the effect of different chemicals upon the conservation of nitrogen in hen manure; also experiments with different varieties of potatoes with reference to their resistance to blight, and the handling of the crop from blighted fields with the idea of discovering a method that will check the rot. Methods of seeding grass and top-dressing experiments with grasses are in progress. Experiments with the Angora goat for clearing underbrush in woods have been continued. A number of box experiments with raw phosphates, in which turnips were grown as a solvent crop preceding a crop of tomatoes, have been finished. When a fair crop of turnips was turned under, nearly as good a growth of tomatoes was secured as when acid phosphate was used. The results of the analyses of cereal foods have been published, and there has been such a wide demand for the results that a reprint of the bulletin has been necessary. One of the features of the poultry investigations of the past year was a study of the floor space needed for different-sized flocks. The results have recently been published in Bulletin 93. Besides the nutrition investigations in cooperation with this Office, the station is cooperating with the Bureau

of Plant Industry in testing vegetables and studying the influence of origin of red-clover seed on yield of crop, and with the Bureau of Chemistry in studying the available plant food in soils. By action of the board of trustees of the university the station officers have been relieved of the management of the university farm and horticultural plantation. Meanwhile the station has the same use of this property for the purpose of investigation that it has had in the past. The station building has been enlarged so that its floor space is nearly doubled, and a new chemical laboratory, an entomological laboratory and office, and a mailing and reading room have been provided in the new addition. A new poultry house is now being erected. The department of zoology has been discontinued, and the department of entomology reestablished. For the present a volunteer assistant will have charge of the entomological work, but it is hoped to enlarge this work in the near future. It is believed that the changes made in the organization of the station and its improved facilities will make its work still more effective. A recent revision of the mailing list by asking persons desiring to keep their addresses on this list to return postal cards to the station has shown that the station has the support of a large farming constituency. With its present resources it is wisely restricting its main work to a few lines. Larger funds could be profitably used in the extension of its work in dairying, entomology, and horticulture, and cooperative field and orchard experiments in different parts of the State.

LINES OF WORK.

The principal lines of work conducted at the Maine Station during the past year were as follows: Chemistry—a study of the effect of chemicals on the conservation of nitrogen in hen manure; of the manurial value of ashes, mucks, seaweeds, and of bone, and of seaweed as a cattle feed, miscellaneous analytical work; botany; inspection of fertilizers, concentrated commercial feeding stuffs, seeds, and creamery glassware; horticulture—experiments in the selection, propagation, and improvement of blueberries; study of hardy fruits and vegetables; diseases of plants—fungus diseases of potatoes and other plants; fruit and nutrition of man and animals; poultry investigations—breeding and feeding experiments; diseases of animals; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000. 00
Farm products.....	2, 818. 92
Fees.....	3, 510. 85
Balance from previous year.....	28. 06
Total.....	21, 357. 83

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 83-91, including two reports on fertilizer inspection, a report on finances and meteorology including an index, and bulletins on the following subjects: Grass thrips, cereal breakfast foods, variation of *Trillium grandiflorum*, potato insecticides and fungicides in 1902, oat smut and its prevention, the chinch bug in Maine, and experiments in orchard culture.

MARYLAND.

Maryland Agricultural Experiment Station, College Park.

Department of Maryland Agricultural College.

GOVERNING BOARD.

Board of Trustees—Agricultural Committee: Governor J. W. Smith, *Annapolis*; Chas. W. Stanley (*Chairman*), *Laurel*; Chas. W. Slagle, *Baltimore*; David Seibert, *Clearspring*; Murray Vandiver, *Harre de Grace*; Chas. A. Councilman, *Glyndon*; Allen Dodge, *Washington, D. C.*; Noble L. Mitchell, *Bel Air*.

STATION STAFF.

H. J. Patterson, B. S., <i>Director; Chemist.</i>	E. O. Garner, <i>Superintendent of Farm, Recorder of Experiments.</i>
J. S. Robinson, <i>Horticulturist.</i>	C. F. Austin, B. S., <i>Associate Horticulturist.</i>
S. S. Buckley, D. V. S., <i>Veterinarian.</i>	T. B. Symons, B. S., <i>Acting Entomologist.</i>
W. T. L. Taliaferro, B. A., <i>Agriculturist.</i>	F. C. Bishopp, B. S., <i>Assistant Entomologist.</i>
C. F. Doane, M. S., <i>Dairy Husbandman and Bacteriologist.</i>	F. H. Blodgett, M. S., <i>Assistant Plant Pathologist, Botanist.</i>
J. B. S. Norton, M. S., <i>Botanist, Vegetable Pathologist.</i>	J. R. Owens, M. D., <i>Treasurer.</i>
	H. H. Howell, <i>Clerk.</i>
	T. H. White, <i>Gardener.</i>

GENERAL OUTLOOK.

The Maryland Station has continued its work along nearly the same lines as formerly. The studies on the influence of preservatives on the digestibility of milk fed to young calves have been closed and results published, which, while not conclusive, seem to indicate that no seriously harmful results followed the use of preservatives, except possibly the falling out of hair on calves fed for a rather long period. It is pointed out, however, that there is little or no occasion for the use of preservatives, and a subsequent bulletin discusses at length

economical methods for improving the keeping qualities of milk without the use of preservative materials. The dairyman is now studying the chemical changes in the composition of milk with advancing lactation, including in the determinations the casein and albumen, as well as the total solids and fat. Attention is also being given to the breeding up of a dairy herd and the growing of forage crops for dairy cows. Alfalfa has been produced quite extensively in the State and gives very satisfactory results.

The station is experimenting with various methods of seeding and inoculating the soil and has taken up work with alkali soils, which are said to be quite prevalent in the State. The chief work of the veterinarian has been in connection with an outbreak of tuberculosis in the herd. About 27 animals are now quarantined, this number including quite a number of young cattle which have been secured in a series of breeding-up experiments with the ordinary cattle of the State. In the horticultural department the practice of growing green crops and composting them has proved very satisfactory as a means of keeping up the greenhouse soil. The entomologist and vegetable pathologist continue to carry on incidental investigations in connection with the horticultural inspection work in the State. The station is cooperating with the Bureau of Plant Industry of this Department in making cereal investigations, variety tests of sweet potatoes, and studies of the influence of origin of red-clover seed on yield of crop; with the Bureau of Chemistry in investigating the gluten content of wheat and the influence of environment on the sugar content of muskmelons, and with the Bureau of Soils in a chemical study of soils and in making a soil survey. There have been a number of changes in the staff during the year, due to resignations to accept positions in this Department or in other stations.

There is increasing evidence that the work of the Maryland Station is influencing the practice of the better farmers of the State, and the \$5,000 appropriation given it by the last legislature was evidence of the appreciation in which it is held. It has considerable work in progress, which is being developed along a few safe and important lines, and there is good opportunity for undertaking important investigations in several other lines. The horticultural interests of the State are very large, and some of the problems affecting them are in need of investigation. This is especially true of diseases and insect pests affecting horticultural crops and problems in truck growing, particularly the application of irrigation to the production of market-garden crops in the vicinity of large cities. At the present time, however, the funds of the station are not sufficient to enable it to undertake additional work.

LINES OF WORK.

The principal lines of work conducted at the Maryland Station during the past year were as follows: Chemistry—analytical work, study of milk preservatives, baking powders, etc.; soils; field experiments—tests of varieties of grasses, forage crops, soil renovators, corn, potatoes, and wheat, cultural, fertilizer, and inoculation experiments, breeding and selection of corn and wheat; horticulture—orchard management, variety tests, cover crops, cultural methods, breeding and selection of strawberries and carnations, rotation of vegetables in the forcing house, systematic study of fruit areas in Maryland; diseases of plants; feeding experiments; dairying; diseases of animals; entomology—inspection of orchards, study of life history of injurious insects.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	5,000.00
Farm products	4,257.58
Balance from previous year	20.40
Total	24,277.98

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1902, and Bulletins 83-88 on thinning fruits, investigations as to the cause of pithiness in celery, feeding experiments with cows, influence of preservatives on the food value of milk, the periodical cicada and its occurrence in Maryland in 1902, and economical methods for improving the keeping qualities of milk.

MASSACHUSETTS.

Hatch Experiment Station of the Massachusetts Agricultural College,
Amherst.

Department of the Massachusetts Agricultural College.

GOVERNING BOARD.

Board of Trustees—Committee on Experiment Department: James Draper (*Chairman*), *Worcester*; J. Lewis Ellsworth, *Boston*; William Wheeler, *Concord*; Elijah W. Wood, *West Newton*; William H. Bowker, *Boston*; Henry H. Goodell, *Amherst*.

STATION STAFF.

H. H. Goodell, LL. D., <i>Director</i> .	W. E. Tottingham, <i>Assistant Chemist</i> (Foods and Feeding).
W. P. Brooks, PH. D., <i>Agriculturist</i> .	E. B. Holland, M. S., <i>First Chemist</i> (Foods and Feeding).
G. E. Stone, PH. D., <i>Botanist, Mycologist</i> .	P. H. Smith, B. S., <i>Assistant Chemist</i> (Foods and Feeding).
C. A. Goessmann, PH. D., LL. D., <i>Honorary Director; Chemist</i> (Fertilizers).	R. H. Robertson, B. S., <i>Assistant Chemist</i> (Fertilizers).
J. B. Lindsey, PH. D., <i>Chemist</i> (Foods and Feeding).	J. G. Cook, B. S., <i>Assistant Chemist</i> (Foods and Feeding).
C. H. Fernald, PH. D., <i>Entomologist</i> .	H. T. Fernald, PH. D., <i>Associate Entomol- ogist</i> .
F. A. Waugh, M. S., <i>Horticulturist</i> .	G. O. Greene, M. S., <i>Assistant Horticul- turist</i> .
J. E. Ostrander, C. E., <i>Meteorologist</i> .	Albert Parsons, B. S., <i>Inspector</i> (Foods and Feeding).
F. R. Church, <i>Assistant Agriculturist</i> .	F. F. Henshaw, <i>Observer</i> .
G. F. Freeman, <i>Assistant Botanist, Mycol- ogist</i> .	G. F. Mills, <i>Treasurer</i> .
N. F. Monahan, <i>Assistant Botanist</i> .	
H. D. Haskins, B. S., <i>Assistant Chemist</i> (Fertilizers).	
J. E. Halligan, B. S., <i>Assistant Chemist</i> (Fertilizers).	
	E. A. Jones, <i>Superintendent of Farm</i> .

GENERAL OUTLOOK.

The work of the Massachusetts Station has not changed materially during the past year. The entomologist has published a catalogue of the Coccidæ of the world and the results of studies on the life history of Aleurodes. He is cooperating with other entomologists in making investigations upon the relation between temperature and insect life. In the department of foods and feeding, digestion and milk experiments with brewers' and distillers' by-products have shown that these materials have a high rate of digestibility, and it is believed that the brewers' grains furnish cheap and quite satisfactory protein sources for milk producers. Malt sprouts, while giving reasonably satisfactory results, are not particularly to be recommended because animals object to the taste. Careful and continued observations failed to show that any of these materials imparted objectionable flavors or odors to the milk. Digestion tests have also been made with apple pomace, soy beans, hominy meal, and other concentrated feeds, and investigations have been started to determine the value of dried blood as a source of protein for milk production. In this department, and also in the department of agronomy, considerable attention is being given to alfalfa, soy beans, and cowpeas. Recent trials have shown that winter wheat and sand vetch sown together about September 1 produce a very desirable green feed for early spring. In the department of agriculture the field and pot experiments are being continued as heretofore, and investigations are being made relative to the feeding

of fowls for eggs for the special purpose of determining the influence of fat in the ration. The department of vegetable pathology and physiology has published recently the results of investigations pertaining to injuries to shade trees from electricity. The results of studies of tomato rots and the pruning of tomatoes are ready for publication, and studies of the influence of soil texture on the growth of roses and of the carnation stem rots have been undertaken. The change of administration in the department of horticulture has resulted in the inauguration of several new lines of work, including experiments in pruning and propagation, and work in systematic pomology. There are also variety tests, cover-crop experiments, cultural experiments, and studies of apple soils. The station is cooperating with the Bureau of Chemistry of this Department in studying the available plant food in soils.

The Massachusetts Station has a considerable amount of work of a scientific character in hand, and has recently strengthened its staff by the appointment of a number of assistants who have no college duties. A simplification has been made in the method of accounting and a system of different-colored vouchers adopted for different funds. The chemical department has better facilities for exact ash analysis, consisting of platinum apparatus for incinerations to secure more exact results regarding the composition of plants. The college has erected a new building, which includes a women's dormitory and a dining hall for students. The State has given funds for quite an extensive college and station exhibit in the educational building at the Louisiana Purchase Exposition.

LINES OF WORK.

The principal lines of work conducted at the Massachusetts Hatch Station during the past year were as follows: Chemistry—miscellaneous analytical work, studies of legumes and plants affecting the quality of butter; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments—soil inoculation, plot experiments with fertilizers, grasses, and various farm crops, supplemented by similar pot experiments; horticulture—varieties of peaches, grapes, and other fruits, raspberry hybrids, investigations with plums, study of the effect of electricity and illuminating gas on plants and trees; diseases of plants, especially those of melons, cucumbers, and lettuce; digestion and feeding experiments; diseases of animals; entomology—study of the life history of economic insects and the use of insecticides; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	11,200.00
Fees	4,215.25
Farm products	2,298.12
Miscellaneous	3,291.04
Total	36,004.41

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 83-87, Meteorological Bulletins 157-173, and the Annual Report for 1902. Bulletins 83, 84, and 85 contain reports of the inspection of fertilizers and feeding stuffs; Bulletin 86 is on orchard treatment for the San José scale, and Bulletin 87 gives the results of seven years of pathological and physiological studies of cucumbers under glass.

MICHIGAN.

Experiment Station of Michigan State Agricultural College, *Agricultural College.*^a

Department of Michigan State Agricultural College.

GOVERNING BOARD.

State Board of Agriculture: Chas. J. Monroe (*President*), *South Haven*; T. F. Marston, *Bay City*; Chas. F. Moore, *St. Clair*; W. H. Wallace, *Bay Port*; Governor A. T. Bliss, *Lansing*; Jonathan L. Snyder (*President of the College*), *Agricultural College*; E. P. Allen, *Ypsilanti*; R. D. Graham, *Grand Rapids*; L. W. Watkins, *Manchester*; B. F. Davis (*Treasurer*), *Lansing*.

STATION STAFF.

C. D. Smith, M. S., <i>Director; Agriculturist.</i>	M. L. Dean, <i>Assistant Horticulturist.</i>
L. R. Taft, M. S., <i>Horticulturist.</i>	B. O. Longyear, B. S., <i>Consulting Botanist.</i>
R. S. Shaw, B. S. A., <i>Live Stock.</i>	Mrs. L. E. Landon, <i>Librarian.</i>
R. H. Pettit, B. S. Agr., <i>Entomologist.</i>	T. A. Farrand, <i>in charge of Substation</i>
C. E. Marshall, Ph. D., <i>Bacteriologist.</i>	(<i>South Haven</i>).
F. W. Robison, B. S., <i>Chemist.</i>	L. M. Geismar, <i>in charge of Substation</i>
F. S. Kedzie, M. S., <i>Associate Chemist.</i>	(<i>Chatham</i>).
G. A. Waterman, M. D. C., <i>Consulting</i>	A. R. Potts, <i>Foreman.</i>
<i>Veterinarian.</i>	Cassius Parsons, <i>Clerk, Stenographer.</i>

^a Freight and express address, *Lansing*.

GENERAL OUTLOOK.

The Michigan Station has continued to give prominence to investigations with sugar beets and leguminous plants, but the nature of the investigations is such that no results along these lines of a positive nature have been announced during the past year. A digestion experiment with sugar-beet pulp to determine its influence on a ration otherwise made up of hay and corn indicated no change in the digestibility of these factors. Vetches grown at this station show a tendency to become dangerous weeds. In addition to the cultural and varietal experiments with legumes, the study of their root nodules and the bacteria peculiar to each legume is occupying the entire time of an assistant bacteriologist. The entomologist has been giving especial attention to a study of means for controlling the mosquito nuisance, and has made some interesting observations on an entomophthorous disease of mosquitoes, which he is now propagating. The veterinarian has successfully used gasoline in the treatment of sheep for intestinal and stomach worms. The botanist has made a study of edible fungi, and published a bulletin on some of the common sorts. He has also made a classification of the vetches. Some interesting experiments in greenhouse construction and management are also in progress. These include the construction, drainage, and aeration of beds for forcing tomatoes, cucumbers, etc. In the dairy division the work with cheese resulted in showing a marked gain from dipping the cheese fresh from the hoop in paraffin.

Among the recently inaugurated investigations are a number of feeding and digestion experiments, studies of poisonous plants and of diseased cattle on the sandy areas of Michigan, and experiments with legumes, soil inoculations, and sand-binding plants. The station is cooperating with a number of farmers in testing soil inoculations with legumes, in fertilizer, cultural, and variety tests of sugar beets, and in growing soy beans, cowpeas, and alfalfa. It continues to cooperate with the Bureau of Plant Industry of this Department in experiments with sand-binding grasses along the lake shores, in studying the influence of the origin of red-clover seed on the yield of crop and in growing sugar-beet seed, and with the Bureau of Chemistry in the investigation of sugar-beet problems, the gluten content of wheat, and the available plant food in soils. The substations at South Haven and at Chatham have been maintained, as heretofore, with State funds.

A laboratory with complete equipment for the chemical work of the station has been fitted up in the veterinary building. The recently completed bacteriological laboratory (Pl. IV, fig. 1) provides not only an excellent bacteriological equipment for students, but also stalls and hospital wards for animals and first-class working laboratories for the station bacteriologist and his assistant. A description of the labora-



FIG. 1.—MICHIGAN COLLEGE AND STATION—BACTERIOLOGICAL LABORATORY, WITH STALLS AND HOSPITAL FOR ANIMALS IN REAR.



FIG. 2.—MISSOURI COLLEGE AND STATION—LABORATORY FOR ANIMAL BREEDING.

tory is to be published soon in a special report. The Michigan Station is making good progress in the improvement of its equipment and the prosecution of useful lines of work. It could profitably give increased attention to horticulture by instituting more thorough and comprehensive investigations along this line, and the resources of the station might well be enlarged for this purpose.

LINES OF WORK.

The principal lines of work conducted at the Michigan Station during the past year were as follows: Chemistry—analysis and control of fertilizers and feeding stuffs, analysis of breakfast foods and condiments; bacteriology—aeration of milk, its effect on gases, souring, etc., study of milk supply and the bacteria of the dairy; soils; field experiments—fertilizer, cultural and variety tests with sugar beets and many other field crops, production of sugar-beet seed, rotations, experiments with cowpeas, soy beans, and other legumes, breeding and selection of wheat; horticulture—variety tests and orchard management; diseases of plants—fungus diseases of the sugar beet, clover, and fruits; feeding experiments—utilization of cowpeas, soy beans, and other legumes, comparison of corn silage with dried corn fodder and with beet pulp, fattening lambs with beet pulp; diseases of animals; entomology, and stable hygiene.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	^a 5,000.00
Fees	2,120.00
Farm products	2,681.10
Miscellaneous, including balance from previous year	2,824.69
Total	27,625.79

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 199–208, Special Bulletins 15–19, and the Annual Report for 1901. The Annual Report contains brief reports by the director and the heads of the different departments and reprints of Bulletins 193–202 and Special Bulletin 16. The bulletins in the regular series include reports of the inspection work of the station, reports from the substations, and the records of investigations on the aeration of milk;

^a For substations.

cowpeas, soy beans, and winter vetch; some insects of the year 1901, mosquitoes and other insects of the year 1902; notes on small fruits; sugar-beet experiments 1902, and Michigan mushrooms. The special bulletins include two spray calendars, technical reports on the aeration of milk, and the investigations with mosquitoes, and a bulletin on sugar beets in the upper Peninsula.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of the University of Minnesota.

GOVERNING BOARD.

Board of Regents: Greenleaf Clark (*President*), *St. Paul*; William M. Liggett, *St. Anthony Park*; Stephen Mahoney (*Secretary*), *Minneapolis*; Elmer E. Adams, *Fergus Falls*; Thomas Wilson, *St. Paul*; A. E. Rice, *Willmar*; O. C. Strickler, *New Um*; James T. Wynman, *Minneapolis*; T. L. Schurmeier, *St. Paul*; Governor Samuel R. Van Sant, *Winona*; Cyrus Northrop, *Minneapolis*; John W. Olsen, *Albert Lea*; J. E. Ware, (*Treasurer*), *Minneapolis*.

STATION STAFF.

W. M. Liggett, <i>Director</i> .	T. A. Hoverstad, B. AGR., <i>Superintendent of Substation (Crookston)</i> .
W. M. Hays, M. AGR., <i>Agriculturist</i> .	H. H. Chapman, B. S., B. AGR., <i>Superintendent of Substation (Grand Rapids)</i> .
S. B. Green, B. S., <i>Horticulturist</i> .	J. A. Hummel, B. AGR., <i>Assistant Chemist</i> .
Harry Snyder, B. S., <i>Chemist</i> .	C. P. Bull, B. AGR., <i>Assistant Agriculturist</i> .
T. L. Haecker, <i>Dairy Husbandman</i> .	A. J. Ruggles, B. S. A., <i>Assistant Entomologist</i> .
M. H. Reynolds, M. D., V. M., <i>Veterinarian</i> .	J. A. Vye, <i>Secretary</i> .
F. L. Washburn, M. A., <i>Entomologist</i> .	
Andrew Boss, <i>Animal Husbandman</i> .	
	Beyer Aune, <i>Farm Foreman</i> .

GENERAL OUTLOOK.

The work of the Minnesota Station has not changed materially during the past year. Breeding investigations with cereals and grasses in cooperation with the Bureau of Plant Industry of this Department and with other northwestern stations continue to occupy a very prominent place in the work of the station. The station has also continued to cooperate with the Bureau of Chemistry in studying the available plant food in soils, with the Bureau of Statistics in securing data relating to the cost of growing field crops and to farm management, and with this Office in nutrition investigations. A study of mosquitoes in cooperation with the Division of Entomology has also been undertaken. The entomologist has succeeded in breeding the Hessian fly, and has thus been enabled to make some advance in the knowledge of this insect. The station chemist in connection with his investigations on the food and nutrition of man is planning to take up work with macaroni wheats.

The substations at Grand Rapids and Crookston have been continued, as heretofore, supported by State funds. At the latter place there are field experiments including variety tests, rotations, and cultural experiments with the principal cereals, and the seeds of promising varieties are distributed throughout the region in which the station is located. It is planned to close out some of the work at this station and during the past season some progress has been made in this direction. Subsequently experiments in animal husbandry will be developed, and a new barn and a silo are to be erected for this purpose. The substation already has a poultry plant, and the experiments with poultry have resulted in some development of both commercial and farm poultry raising in the vicinity. There are also forestry experiments, tests of different kinds of vegetables, and some work with hedges. The matter of farm drainage is also being agitated, and a movement has been started for the establishment of an agricultural high school at Crookston for Red River Valley pupils.

The Minnesota Station continues to be a strong factor in the development of the agricultural interests in the State. It has quite a liberal income and the last legislature made grants for new buildings for the college and station amounting to \$300,000, and yet the demands made upon the station are so great that it has been necessary to curtail some of the investigations during the past year for lack of sufficient funds. The university has recently come under the management of a State board of control, established to manage the finances of all penal, charitable, and educational institutions in the State.

LINES OF WORK.

The principal lines of work conducted at the Minnesota Station during the past year were as follows: Chemistry of soils and farm crops; field experiments—rotations, tests of varieties of cereals and forage crops, proportion of flax and wheat to use when sown together, time and depth of seeding grains and amount of seed, methods of seeding grasses; horticulture—tests of varieties of fruits and vegetables, use of wind-breaks, testing hardy stocks for apple trees, improvement of native fruits; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15, 000. 00
State appropriation, including substations..	43, 882. 06
Farm products, including substations.....	13, 137. 14
Total	<u>72, 019. 20</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 73-81 and the Annual Report for 1902. The subjects of the regular bulletins are as follows: Growing swine of various breeds and crosses; human food investigations; fattening lambs, 1902; fattening steers, 1902; insects notably injurious in 1902; experiments in sheep husbandry; investigations in milk production; alfalfa, its chemical development, feeding value, and digestibility; the digestibility of hog millet; review of the work of the Northeast Experiment Farm since its organization in May, 1896.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.*^a

Department of Mississippi Agricultural and Mechanical College.

GOVERNING BOARD.

Board of Trustees: Governor A. H. Longino (*President ex. officio*), Jackson; R. C. King (*Secretary*), *Agricultural College*; Thaddeus Lampton (*Treasurer*), Jackson; F. L. Hogan, *Starkville*; T. L. Wainwright, *Stonewall*; T. C. Dockery, *Love Station*; J. T. Harrison, *Columbus*; W. C. George, *Greenwood*; W. H. Morgan, *Sheppardtown*; J. J. Coman, *Jackson*; Henry L. Whitfield, *Jackson*; A. T. Dent, *Macon*; J. B. Bailey, *Conchatta*; J. C. Hardy (*President of the College*), *Agricultural College*.

STATION STAFF.

W. L. Hutcheson, M. S., <i>Director; Chemist.</i>	A. B. McKay, B. S., <i>Horticulturist.</i>
E. B. Ferris, M. S., <i>Assistant Director in charge of McNeill Substation.</i>	J. C. Robert, V. M. D., <i>Veterinarian.</i>
E. R. Lloyd, M. S., <i>Assistant Director; Agriculturist.</i>	W. R. Perkins, M. S., <i>Associate Chemist.</i>
G. W. Herrick, B. S., <i>Botanist, Entomologist.</i>	H. S. Chilton, B. S., <i>Assistant Chemist.</i>
	J. S. Moore, M. S., <i>Dairy Husbandry.</i>
	R. C. King, B. S., <i>Treasurer.</i>
	John Phares, <i>Foreman of McNeill Substation.</i>
	Maude Butler, <i>Stenographer.</i>

GENERAL OUTLOOK.

The Mississippi Station continues to direct its efforts mainly to the solution of problems in animal production, dairying, and the improvement of soils. In animal production the experiments with beef cattle in testing the relative value of home-grown and commercial feeds is most extensive. Incidental to this work is the investigation of problems in producing pasturage and hay, the latter from wheat, oats, cow-peas, sorghum, and Johnson grass. In dairying various problems in

^a Telegraph address, *Starkville*. Express and post-office address, *Agricultural College*. Freight address, *A. and M. College Station*.

feeding and caring for pure-bred cows and in handling dairy products are receiving attention. Recent experiments with a flock of about 45 sheep indicate that these animals are well suited to the conditions existing in the State and desirable in farm practice. Work has also been started with swine and with brood mares for raising mules. The work with soils has included analytical work, the improvement of pastures, and a soil survey in cooperation with the Bureau of Soils of this Department. The entomologist has published results of his work with chicken mites and the Colorado beetle, and is giving considerable attention to the harlequin cabbage bug, San José scale, bean leaf beetle, and the cotton boll weevil. These investigations are in cooperation with the Division of Entomology of this Department.

The investigations with fertilizers have been conducted mainly at the McNeill Substation, although some work of this kind has been done in connection with the horticultural work at the station, and some in cooperation with farmers. The McNeill Substation is located in the longleaf pine region of southern Mississippi, where the soils are unproductive without the use of fertilizers of some sort. The results obtained with fertilizers under several different crops last year indicated a need for superphosphates and nitrogenous fertilizers, but not for potash. Green manuring tests, pasturing experiments, and rotation experiments are also being made at the substation.

The Mississippi Station has a considerable amount of valuable work in progress in all of its departments. A new science building for the college will give the station better quarters for its departments of agriculture, horticulture, and entomology. During the year there has been considerable progress in making a clearer differentiation of college and station work with definite assignments of land for experimental work in horticulture, agronomy, animal production, and dairying, and a lessening of the college duties of station men, with readjustment of salaries to the advantage of the station. The station is, therefore, in a much better position to conduct investigations of real and permanent value to the agriculture of the State. The State is showing its appreciation of the work of the station by more liberal contributions to its resources, but considering the predominant agricultural interests of Mississippi, the operations of the station could be profitably conducted on a larger scale than its present revenues will permit.

LINES OF WORK.

The principal lines of work conducted by the Mississippi Station during the past year were as follows: Soils—restoring and maintaining fertility, study of artesian waters, methods of preventing erosion, and restoring washed soils; fertilizers; field experiments—growing pasturage and forage crops, testing varieties of wheat, oats, and cotton; horticulture; animal husbandry—beef production, combined

with swine and sheep production; dairying; diseases of animals—Texas fever and other diseases; entomology—chicken mite, and insects affecting the leading garden and farm products.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Farm products	808.07
Miscellaneous, including balance from previous year.	1,409.30
Total	17,217.37

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 76-80 and the Annual Report for 1902. The bulletins included reports of investigations on beef cattle, the chicken mite, and the work of the year at the McNeill Substation, and a farmers' institute bulletin.

MISSOURI.

Missouri Agricultural College Experiment Station, Columbia.

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

GOVERNING BOARD.

Board of Curators—Executive Committee: Walter Williams (*Chairman*), *Columbia*; Campbell Wells, *Platte City*; J. F. Gmelich, *Boonville*.

Advisory Council: The Missouri State Board of Agriculture.

STATION STAFF.

H. J. Waters, ^a B. S. A., <i>Director</i> .	G. M. Tucker, B. S., Ph. D., <i>Agronomist</i> .
F. B. Mumford, M. S., <i>Acting Director</i> ; <i>Animal Breeding</i> .	W. L. Howard, B. S., <i>Assistant Horticulturist</i> .
Paul Schweitzer, Ph. D., LL. D., <i>Chemist</i> .	B. M. Duggar, Ph. D., <i>Botanist</i> .
J. C. Whitten, M. S., Ph. D., <i>Horticulturist</i> .	H. S. Reed, B. A., <i>Assistant Botanist</i> .
J. M. Stedman, B. S., <i>Entomologist</i> .	R. M. Bird, Ph. D., <i>Acting Chemist</i> .
G. I. Reeves, B. S., <i>Assistant Entomologist</i> .	E. H. Favor, B. A., <i>Assistant Horticulturist</i> .
J. W. Connaway, M. D. C., M. D., <i>Veterinarian</i> .	M. W. Harper, M. S., <i>Assistant in Feeding</i> .
C. H. Eckles, B. Agr., M. S., <i>Dairying</i> .	John Schnabel, <i>Gardener</i> .
E. B. Forbes, B. S., <i>Animal Husbandman</i> .	J. G. Babb, M. A., <i>Secretary</i> .
	R. B. Price, <i>Treasurer</i> .
	Estelle Hickok, <i>Clerk, Stenographer</i> .

^a On leave.

GENERAL OUTLOOK.

The work of the Missouri Station has progressed steadily and in a very satisfactory manner. In the department of animal husbandry cattle-feeding experiments of considerable importance, partly in cooperation with the Bureau of Animal Industry of this Department, have been conducted to determine the economy of using cotton-seed meal for fattening cattle and the efficiency of Missouri bluegrass for finishing prime cattle. Breeding experiments with guinea pigs, mice, and pigeons have been undertaken to determine, among other things, the influence of birth weight upon development and maturity. It has been found that a heavy birth weight is distinctly favorable to vigorous development and early maturity. Other problems in breeding will be undertaken and given prominence in the work of the station. The horticulturist has continued his investigations on the culture and care of fruits, and is doing considerable work in grafting and selecting. The relation of color of twigs to hardiness of peach trees is being investigated, also problems in the irrigation of strawberries, garden vegetables, and nursery stock in cooperation with this Office. In dairying some of the problems studied are an improved method of testing cream for fat, the effect of spaying milch cows, and the economic value of fly repellents. In the chemical department a dry Bordeaux mixture has been devised. The agronomist is studying rotations, alfalfa culture under various soil conditions, and northern and home-grown seed of wheat, oats, and corn. He is cooperating with farmers in growing alfalfa and in testing fertilizers for corn and soil inoculations. A part of this work is also in cooperation with the Bureau of Plant Industry of this Department, with which the station is cooperating in testing the formation and management of meadows and pastures and the influence of origin of red-clover seed on yield of crop. With the Bureau of Chemistry the station is studying the available plant food in soils and investigating the gluten content of wheat.

The Missouri Station is growing rapidly in number of investigators and material equipment. Its building operations of the past year, which have included the completion of a fine new \$40,000 stone building for horticulture, botany, and entomology, a stone building for veterinary science and animal husbandry, including a laboratory of animal breeding (Pl. IV, fig. 2), and new barns and feeding sheds, have temporarily interrupted its work in some lines, but it is in better shape than ever before for work of high grade. It is making an interesting and very valuable study of "baby beef" production. Dairy work is being taken up and has a close connection with work in beef production. The fruit interests of the State now exceed those of any other State in area of orchards, and its work in this line is a prominent feature. The station continues to take quite a prominent part in the farmers' insti-

tute work and, while this encroaches upon the time of the station men, it has been quite beneficial in bringing the station prominently before the farmers, who in turn have given it their confidence and support in a marked degree. The station men are also doing much to aid in the work of the college of agriculture for the introduction of elementary agriculture teaching in the public schools. The station director has been given leave of absence for the purpose of taking charge of the preparation of the State agricultural exhibit at the Louisiana Purchase Exposition, and Prof. F. B. Mumford has been made acting director.

Considering its limited revenues this station is doing a relatively large amount of useful work, and now that better facilities have been provided in the new buildings it could profitably utilize larger funds in extending its operations, which, in view of the great agricultural interests of the State, should be conducted on a larger scale.

LINES OF WORK.

The principal lines of work conducted at the Missouri Station during the past year were as follows: Chemistry—inspection of fertilizers, study of food adulterants and fungicides; field experiments—cereal and forage crops, fertilizers, rotations, renovating worn-out soils; horticulture—experiments with apples, plums, grapes, peaches, pears, small fruits, and nuts, breeding experiments with fruits, diseases of apples; breeding experiments; feeding experiments with beef cattle, sheep, and swine; diseases of animals, especially those of swine; entomology—study of ticks on cattle, parasites of sheep, and insects affecting fruits; dairying; and drainage and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Fees.....	2,488.44
Farm products.....	2,838.46
Balance from previous year.....	3,229.61
Total.....	<u>23,556.51</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 51–60 and Circulars of Information 10–16. The subjects treated in the bulletins are as follows: The chinch bug, influence of height of wheel on the draft of farm wagons, breeding experiments

with sheep, two insects injurious to the strawberry, pruning peach trees, dairy husbandry, raising calves with skim milk, feeding the dairy cow, corn improvement for Missouri, and a new Bordeaux powder.

Missouri State Fruit Experiment Station, Mountain Grove.

GOVERNING BOARD.

Trustees: J. C. Kerby (*President*), *West Plains*; C. B. McAfee (*Treasurer*), *Springfield*;
T. M. Culver (*Secretary*), *Koshkonong*.

STATION STAFF.

Paul Evans, *Director*.

Frank Horsfall, B. S., *Assistant Horticulturist*.

F. W. Faurot, B. S., *Assistant in Investigation of Plant Diseases*.

A. M. Swartwout, *Field Assistant*.

GENERAL OUTLOOK.

Owing to the crop failure of 1902 the Missouri State Fruit Experiment Station decided to defer experimental work on diseases and insects injurious to fruit until next year, and devote attention more especially to extending the orchards and making general improvements. These orchards now contain 260 varieties of apples, 200 peaches, 160 strawberries, 100 grapes, and quite a number of raspberries, blackberries, currants, gooseberries, and other small fruits. The orchard of seedlings bred at this station now includes over 1,200 varieties, comprising peaches, apples, and strawberries. It is the intention of the station authorities to make the practical work, such as the testing and improvement of varieties, a prominent feature. At the same time considerable attention will be given to the study of the more important diseases of orchard and small fruits. A new barn and an implement house have recently been completed, and plans are being made for a greenhouse to be erected during the next season.

LINES OF WORK.

The principal lines of work conducted at the Missouri State Fruit Experiment Station during the past year were as follows: Horticulture—experiments with fertilizers and cover crops for orchards; breeding experiments with apples, peaches, and strawberries; orchard survey; tests of new land for orchard purposes; study of crown gall, bitter rot, root rot, and other diseases affecting fruits; experiments and studies of injurious insects; experiments with insecticides and fungicides, and inspection of orchards and nurseries.

INCOME.

The station is supported entirely by State appropriations, the amount for the years 1903 and 1904 being \$32,000. Of this sum a total of \$10,740.39 was expended during 1903.

MONTANA.

Montana Agricultural Experiment Station, Bozeman.

Department of the Montana College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Executive board: Walter S. Hartman (*President*), Bozeman; Peter Koch (*Secretary and Treasurer*), Bozeman; John M. Robinson, Bozeman; Joseph Kountz, Bozeman; E. B. Lamme, Bozeman.

STATION STAFF.

S. Fortier, ^a M. E., <i>Director; Irrigation Engineer.</i>	R. W. Fisher, B. S., <i>Assistant Horticulturist.</i>
V. K. Chesnut, <i>Chemist.</i>	Edmund Burke, <i>Assistant Chemist.</i>
F. B. Linfield, B. S. A., <i>Acting Director; Agriculturist, Animal Husbandman.</i>	J. W. Blankinship, Ph. D., <i>Botanist.</i>
	R. A. Cooley, B. S., <i>Zoologist.</i>
	W. J. Elliott, <i>Assistant Dairyman.</i>
	M. A. Lamme, <i>Stenographer, Clerk.</i>

GENERAL OUTLOOK.

The Montana Station has continued many of the investigations previously reported, and has arrived at some conclusions of considerable value. The data from four years' experiments in feeding steers and sheep in earload lots are now available for publication. The results of investigations with poisonous plants have been published and some suggestions made which, if put in practice, should lead to a great decrease in the poisoning of animals. The investigations with sugar beets show that a number of valleys in Montana, particularly those of the Bitter Root and Yellowstone rivers, are well adapted to the production of sugar beets. The pure-food investigations have brought some valuable results. The station has recently announced its discovery of salicylic acid as a normal constituent of several kinds of fruit, and it is possible that the acid thus normally found in fruit has been at times mistaken for an adulterant. The irrigation investigations in cooperation with this Office have been continued as a leading feature of the station work. The director is now on leave of absence for a year to take charge of the irrigation investigations of this Office in California, and the agriculturist is acting director.

Some new lines of work have been taken up during the year, notably some preliminary work in experiments on dry land and on testing the effect of early spring and late fall irrigation. A beginning has been made also in dairy investigations, which will be considerably extended in the ensuing year. Cultures of fungus for the destruction of grasshoppers have been sent out to some extent. A new seed barn and granary and a central heating plant have been erected, and an appro-

^a On leave.

priation is available for a new cattle barn to accommodate from 75 to 80 head of cattle. The chemist of the station has recently resigned to go to the State University at Boulder, Colo. The station has an increased income from farm receipts and from the State, and is in better condition than ever before for useful work, but the large extent of the State and the pressing need of studies of problems connected with the development of new agricultural regions make it impracticable for this station to satisfy the demands made on it with its present resources.

LINES OF WORK.

The principal lines of work conducted at the Montana Station during the past year were as follows: Chemistry—study of alkali soils, alkali limit of plant growth, effect of mine tailings on vegetation, effect of various rotations on soils, sugar-beet investigations, food inspection and miscellaneous analytical work; meteorology; botany—study of plants utilized by Indians, plants poisonous to stock, and other systematic work; field experiments—rotations, improvement of cereals, cooperative sugar-beet tests, test of grasses and forage crops; horticulture—orchard and small fruits and forest trees; feeding experiments—cattle and sheep; poultry experiments; entomology—codling moth and other insects affecting fruits, vegetables, and shade trees; irrigation—duty of water, losses by evaporation, seepage, methods of application, study of water rights, and plant and pot experiments to determine the water requirements of plants and methods of application.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000. 00
State appropriation	5, 120. 97
Farm products	4, 568. 60
Total ..	<hr/> 24, 689. 57

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 35-44 and the Annual Report for 1902. The bulletins include reports on investigations with beef cattle and sheep, forage conditions of central Montana, pork production in Montana, root crops in Montana, food adulteration, sheep feeding in Montana, sugar beets—the crop of 1902, the codling moth, the duty of water in Montana, and apple growing in Montana.

NEBRASKA.

Agricultural Experiment Station of Nebraska, *Lincoln.*

Department of the University of Nebraska.

GOVERNING BOARD.

Regents of the University: George F. Kenower (*President*), *Wisner*; E. von Forell, *Aurora*; Carl J. Ernst, *Omaha*; Elisha C. Calkins, *Kearney*; Edson P. Rich, *Omaha*; John L. Teeters, *Lincoln*; James S. Dales (*Secretary*), *Lincoln*.

STATION STAFF.

E. A. Burnett, B. S., <i>Director; Animal Husbandman.</i>	O. V. P. Stout, C. E., <i>Irrigation Engineer.</i>
T. L. Lyon, B. S. A., <i>Associate Director; Agriculturist.</i>	Samuel Avery, Ph. D., <i>Chemist.</i>
H. H. Nicholson, M. A., <i>Chemist.</i>	R. A. Emerson, B. S., <i>Horticulturist.</i>
C. E. Bessey, Ph. D., LL. D., <i>Botanist.</i>	A. L. Haecker, B. S., <i>Dairy Husbandman.</i>
Lawrence Bruner, B. S., <i>Entomologist.</i>	H. R. Smith, B. S., <i>Animal Husbandman.</i>
E. H. Barbour, Ph. D., <i>Geologist.</i>	J. H. Gain, M. D. C., <i>Assistant Animal Pathologist.</i>
A. T. Peters, D. V. M., <i>Animal Pathologist.</i>	W. P. Snyder, <i>Assistant in Animal Husbandry.</i>
G. D. Swezey, M. A., <i>Meteorologist.</i>	S. W. Perrin, <i>Farm Foreman.</i>
	J. S. Dales, Ph. M., <i>Financial Secretary.</i>
	W. W. Marshall, <i>Executive Clerk.</i>

GENERAL OUTLOOK.

The Nebraska Station has continued the main lines of investigation previously reported. The results of eight different feeding experiments with cattle and pigs have been published. These experiments extended over a series of years and included a large number of tests of different rations to compare different kinds of roughage alone and in combination with grains. In experiments to determine the best week in a cow's lactation it was found that nine-tenths of the cows made their best records during the first ten weeks of lactation, and that over one-half made their best records during the first month. An effort is being made to improve corn by the selection of varieties adapted to the different sections of the State and by the selection of individual plants of desirable qualities. Investigations are in progress to determine a cheap and effective method of destroying pocket gophers and prairie dogs. Experiments in dipping cattle for psoroptic scabies are in progress.

Investigations in cooperation with about 1,700 farmers are being carried on to test varieties of corn, winter wheat, macaroni wheat, and Kherson oats, several of these cereals being varieties introduced by this Department. Forestry plantations are continued in cooperation with the Bureau of Forestry, also studies of the influence of environment on plants in cooperation with the Bureau of Plant Industry, and irrigation investigations in cooperation with this Office. Recently the station has undertaken an investigation of the conditions and limitations

incident to the extension of the dairy industry in the short-grass country between the Mississippi River and the Rocky Mountains in cooperation with the Bureau of Plant Industry. The work of the station in farmers' institutes is considerable. The appropriation for this work has been increased to \$12,000 for the next biennium and an assistant for farmers' institutes is to be employed.

The last legislature appropriated \$15,000 for the establishment of a substation west of the one hundredth meridian in Nebraska. This station has been located at North Platte, where it is expected that three sections of land will be available for experimental purposes. The legislature also made an appropriation of \$100,000 for new buildings for the school of agriculture. These will include a \$60,000 main building, a dairy barn and machine shop costing \$11,000 each, a horticultural building and greenhouse costing \$7,000, and an extension of the heating plant costing \$4,000. These improvements will greatly increase the facilities of the experiment station.

The Nebraska Station is receiving more liberal treatment from the State than formerly, but could profitably use much larger funds in extending its work along the lines of corn breeding, cooperative feeding, animal pathology, study of macaroni wheats, development of cream and cheese production, and the study of irrigation waters. Owing to the urgent demand for larger experiments with dairy cattle, different kinds of roughage for milk, etc., the station needs more animals for feeding experiments.

LINEs OF WORK.

The principal lines of work conducted at the Nebraska Station during the past year were as follows: Chemistry; botany; meteorology; soils—sources of moisture, moisture as affected by different crops, aeration, and fertilization; field experiments—rotations, breeding experiments, grasses and legumes, sugar beets, winter wheat, corn, soy beans, and imported grains; horticulture—development of hardy varieties of fruits by hybridization, grafting, and selection, and breeding of beans; diseases of plants; forestry; feeding and breeding experiments; diseases of animals—cholera in hogs, dysentery in calves, abortion, mange, sorghum poisoning, cornstalk disease; entomology—grasshopper fungus disease, chinch-bug disease; irrigation—records of water used on different crops, methods of cultivation, and records of discharge of several rivers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products, including balance from previous year....	4,865.78
Total.....	19,865.78

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 75-79. Bulletin 75 records the results of eight different feeding experiments with cattle and pigs. The other bulletins include reports on the poisoning of cattle by sorghum and Kalir corn, macaroni wheats, experiments with the dairy herd, and experiments in orchard culture.

NEVADA.

Nevada Agricultural Experiment Station, Reno.

Department of Nevada State University.

GOVERNING BOARD.

Regents of University: J. N. Evans (*President*), *Reno*; W. W. Booher, *Elko*; Richard Kirman, *Reno*; George H. Taylor (*Secretary*), *Reno*.

STATION STAFF.

J. E. Stubbs, M. A., D. D., <i>Director</i> .	G. H. True, B. S., <i>Agriculturist, Animal</i>
N. E. Wilson, M. S., <i>Vice-Director; Chemist</i> .	<i>Husbandman</i> .
Peter Frandsen, M. A., <i>Zoologist, Bacteriologist</i> .	Elizabeth S. Stubbs, B. A., <i>Stenographer</i> .
P. B. Kennedy, Ph. D., <i>Botanist, Horticulturist</i> .	S. B. Doten, B. A., <i>Entomologist</i> .
	C. R. Fitzmaurice, <i>Assistant Chemist</i> .
	T. W. Clark, <i>Farm Foreman</i> .
	I. W. Ayres, M. A., <i>Librarian</i> .

GENERAL OUTLOOK.

The Nevada Station has not made any material changes in its work except in the department of agriculture and animal husbandry, where some new lines of work in irrigation to determine the duty of water and experiments with root crops as a feed supplementary to alfalfa have been undertaken. The equipment of this department has been improved by the purchase of a pair of pure-bred Percheron horses, some pure-bred swine, and about \$800 worth of high-grade Holstein cattle. The chemical department also has better facilities in the new building recently occupied, and is doing some work with soils and with wheat to determine the relative amounts of gluten in several varieties. The entomologist, who has also been making improvements in the equipment of his department, has been studying the codling moth and making cooperative demonstration experiments in a number of different localities on destructive crickets, grasshoppers, and red spiders. The botanist and horticulturist has been working up

the station herbarium, studying range conditions before and after sheep grazing, and making some observations on poisonous plants. The zoologist has continued making a collection of birds, with observations on their food habits, and has recently undertaken similar work with rodents, particularly those destructive to agriculture. He also has consulting work in veterinary science, and has given attention to outbreaks of big head in sheep, hog cholera, and anthrax. The irrigation work of the station is in cooperation with this Office.

The Nevada Station has added considerably to the strength of its staff and is coming into closer touch with the farmers of the State, but the equipment is still meager notwithstanding recent additions. The library of the station has not been in condition for use, but recently room has been provided for it and it is now being classified and arranged. Farmers' institutes were held in three different places, with a total attendance of 983, thus showing that the people are taking a great interest in the improvement of agricultural conditions. This condition of affairs emphasizes the desirability of having the station put in a position to prosecute its work with greater vigor and on a larger scale. It is especially desirable that its operations in animal husbandry and irrigation should be extended.

LINES OF WORK.

The principal lines of work conducted at the Nevada Station during the past year were as follows: Chemistry; botany—studies of poisonous plants and of range plants eaten by sheep; soils; field experiments—tests of varieties of wheat, grasses, and other forage plants, experiments with different quantities of seed and with barnyard manure; horticulture; forestry; animal diseases—hog cholera, anthrax, and big head of sheep; entomology; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products.....	345.33
Balance from previous year.....	226.56
Total.....	15,571.89

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1902 and Bulletins 52-54, on water supply and irrigation in Nevada, the burning of dead animals, and report of irrigation investigations, Humboldt River Valley, Nevada.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham*.

Department of New Hampshire College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Control: John G. Tallant (*Chairman*), *Pembroke*; Warren Brown, *Hamp-ton Falls*; George A. Wason, *New Boston*; Chas. W. Stone (*Secretary*), *Andover*; W. D. Gibbs (*President*), *Durham*.

STATION STAFF.

W. D. Gibbs, M. S., <i>Director</i> .	E. L. Shaw, B. S., <i>Assistant Agriculturist</i> .
F. W. Morse, M. S., <i>Vice-Director; Chemist</i> .	H. H. Scudder, B. A., <i>Assistant Chemist</i> .
C. M. Weed, D. Sc., <i>Entomologist</i> .	J. C. Bridwell, B. S., <i>Assistant Entomolo-</i>
F. W. Rane, B. Agr., M. S., <i>Horticulturist</i> .	<i>gist</i> .
F. W. Taylor, B. S., <i>Agriculturist</i> .	Edith M. Davis, <i>Purchasing Agent</i> .
I. C. Weld, <i>Dairy Manufactures</i> .	H. F. Hall, <i>Gardener</i> .
Mabel E. Townsend, <i>Stenographer</i> .	

GENERAL OUTLOOK.

The work of the New Hampshire Station during the past year was seriously affected by the resignation of the director and agriculturist early in the year, and of the president of the college in the latter part of the year. All of the station officers had their work increased by the division among them of other duties made necessary by these changes, and the progress of investigations was considerably hindered. Feeding experiments were suspended, and field experiments and chemical investigations were much curtailed. Climatic conditions were also very unusual during the growing seasons and made the results of field experiments very irregular. However, some important results were secured in the study of forage crops, and a successful experiment in suppressing black flies by the use of oil on their breeding places was conducted in cooperation with a mountain hotel.

The vacancies on the college and station staff have now been filled by the election of William D. Gibbs, of Texas (formerly director and agriculturist of the New Hampshire Station), to the position of president of the college and director of the station, and the election of an agriculturist and an assistant agriculturist of the station. The experiments in fertilizing grass lands in cooperation with this Department and with farmers have been concluded with indefinite results. The tests of novelties and studies of the influence of the origin of red-clover seed on yield of crop, in cooperation with the Bureau of Plant Industry of this Department, have been continued. New lines of work are now being undertaken, notably studies of the available fertility of the soil, by the chemist; the establishment of an orchard for the purpose of studying problems of fruit growing on rocky pastures, by the horticulturist, and the beginning of a practical collection of forest-tree seeds.

A new college agricultural and horticultural building was dedicated recently with appropriate exercises. It furnishes additional office room and facilities for station work in agronomy, animal husbandry, horticulture, and forestry. The last legislature made an appropriation of \$13,000 for equipping this building, also \$15,000 for general expenses of the college, \$7,000 for a college and station greenhouse which is now building, and \$5,000 for additions to the heating plant. An addition of about \$1,000 to station funds is realized from the inspection of feeding stuffs, nurseries, and nursery stock in cooperation with the State Board of Agriculture. The staff and equipment of the New Hampshire Station are now in good condition for useful and progressive work, but there is need of additional funds for work in animal husbandry and for cooperative work in different parts of the State.

LINES OF WORK.

The principal lines of work conducted at the New Hampshire Station during the past year were as follows: Chemistry—study of yield of dry matter and digestible nutrients in corn and hay, loss of nutrients in corn fodder under different methods of storing; analysis of fertilizers and feeding stuffs; field experiments—crop rotations, variety tests of early corn; horticulture—tests of varieties of muskmelons, potatoes, strawberries, tomatoes, and other fruits and vegetables, experiments in forcing vegetables, renovation of old orchards; entomology—suppression of insect pests, and a study of the life zones of the principal insects of the State.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000. 00
Fees	1,209. 97
Total	<u>16,209. 97</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 91-101 on the following subjects: Killing woodchucks with carbon bisulphid; silage studies; cold storage of apples; remedies for fleas; how to grow a forest from seed; Annual Report for 1901; inspection of fertilizers in 1902; a selected list of vegetables for the garden; the white fly of greenhouses, and fungus diseases and spray-

ing. There were also received Technical Bulletin No. 5, A Partial Bibliography of the Economic Relations of North American Birds; and Technical Bulletin No. 4, Effect of Acetylene Gaslight on Plant Growth.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

GOVERNING BOARD.

Board of Managers: Gov. Franklin Murphy, *Newark*; Austin Scott, *New Brunswick*; Edward B. Voorhees, *New Brunswick*; Ephraim T. Gill, *Haddonfield*; John F. Driver, *Mullica Hill*; H. L. Sabsoyich, *Woodbine*; John E. Darnell, *Masonville*; David D. Denise (*President*), *Freehold*; James Neilson, *New Brunswick*; Samuel B. Ketcham (*Vice-President*), *Pennington*; Peter V. D. Van Doren, *Millstone*; Ogden Woodruff, *Elizabeth*; Melvin S. Condit, *Boonton*; Abram C. Holdrum, *Westwood*; Wm. H. Belcher, *Paterson*; George E. De Camp, *Roseland*; Cyrus B. Crane, *Caldwell*; George Dorer, *East Orange*; Joseph B. Ward, *Lyons Farms*; Philip M. Brett, *Jersey City*; John Hudson, *Jersey City*; Henry Bell, *Union Hill*; H. A. Gaede, *Hoboken*.

STATION STAFF.

E. B. Voorhees, D. Sc., <i>Director</i> .	J. B. Smith, D. S., <i>Entomologist</i> .
I. S. Upson, M. A., <i>Chief Clerk, Secretary,</i> <i>Treasurer.</i>	A. T. Jordan, B. S., <i>Horticulturist</i> .
L. A. Voorhees, M. A., <i>Chief Chemist</i> .	J. G. Lipman, M. A., <i>Soil Chemist, Bacteriologist</i> .
J. P. Street, M. S., <i>Associate Chemist</i> .	G. A. Billings, B. S., <i>Dairy Husbandman</i> .
W. P. Allen, B. S., <i>Assistant Chemist</i> .	Mary A. Whitaker, <i>Stenographer and</i> <i>Typewriter.</i>
V. J. Carberry, <i>Assistant Chemist</i> .	H. W. Williams, <i>Janitor</i> .
G. H. Burton, <i>Laboratory Assistant</i> .	

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

GOVERNING BOARD.

Board of Trustees, Experiment Station Committee: Austin Scott (*Chairman*), *New Brunswick*; Henry W. Bookstaver, *24 East Sixty-fourth street, New York City*; James Neilson, *New Brunswick*; Paul Cook, *Troy, N. Y.*; William H. Leupp, *New Brunswick*; John W. Herbert, jr., *Helmetta*.

STATION STAFF.

E. B. Voorhees, D. Sc., <i>Director</i> .	J. A. Kelsey, M. S., <i>Field Assistant</i> .
Julius Nelson, Ph. D., <i>Biologist</i> .	I. S. Upson, M. A., <i>Disbursing Clerk,</i> <i>Librarian.</i>
B. D. Halstead, D. Sc., <i>Botanist, Horticulturist</i> .	Augusta E. Meske, <i>Stenographer and Type-</i> <i>writer.</i>
J. B. Smith, D. Sc., <i>Entomologist</i> .	

GENERAL OUTLOOK.

The New Jersey Stations continue to give special attention to a few important lines of work which have been followed systematically for a number of years. In addition to these, certain new lines of work have been developed in recent years. These include studies of the breeding

habits and means of destroying mosquitoes; investigations in soil bacteriology, especially on nitrogen-fixing bacteria; investigations of commercial feeding stuffs; studies in oyster culture; a comprehensive study of the fertilizing value of animal and green manures; plant-breeding experiments; experiments in the culture and utilization of forage and soiling crops; and the value of nitrate of soda for garden and field crops. In the investigation of feeding stuffs it was found that the number of spurious articles on the market was very much reduced over those of previous years, undoubtedly due to the inspection carried on and the educational character of the publications connected therewith. Investigations concerning the appropriation of nitrogen by plants from various forms of nitrogenous substances have been finished in one of its phases, and the results confirm those obtained elsewhere in showing a relatively high availability for such products as dried blood, meat tankage, and cotton-seed meal, and in showing a much higher rate of availability for ground horn than was formerly assigned to it. In the investigation of the mosquito problem much progress has been made and the results thus far secured encourage the hope that the methods suggested may result in materially reducing, if not wholly eradicating, this pest. The station is also cooperating with the Division of Entomology of this Department in studies of cranberry insects, the San José scale, and the Asiatic lady-bird. The irrigation studies in cooperation with this Office show a comparatively large number of small irrigation plants in operation in the market-gardening districts adjacent to the large Eastern cities. The operations of these plants are uniformly profitable, and it is evident that they could be handled with very great advantage.

The director of the stations, Dr. E. B. Voorhees, has been awarded the William H. Nichols medal for the year ended July 1, 1902, on his paper "Studies in denitrification," presented before the New York section of the American Chemical Society and published in the *Journal of the American Chemical Society*. This medal is awarded annually to the author who presents before the New York section of the American Chemical Society the best paper embodying the results of original chemical research. Competition is not restricted to members of the American Chemical Society, nor necessarily to those who present papers in person.

The stations suffered great temporary loss through the destruction by fire of the station building on April 23. A large proportion of the records and collections was saved. The structure is now being rebuilt with insurance funds and will furnish better facilities for the various departments than hitherto. The work of these stations is so systematically and thoroughly organized and has proved so practically useful that there is no doubt that with larger resources they would make still more important contributions to the advancement of the agricultural interests of New Jersey.

LINES OF WORK.

The principal lines of work conducted at the New Jersey Stations during the past year were as follows: Chemistry—study of adulterants of feeding stuffs, chemical composition and relative value of the various kinds of lime used in the State, methods of examining insecticides, studies of the losses of nitrogen in barnyard manures; biology—oyster culture; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments—forage crops, soiling crops, experiments with fertilizers and garden crops, experiments with barnyard manures; horticulture—cultural experiments with orchard and small fruits, ornamentals and vegetables, cross fertilization of eggplants, sweet corn, cucumbers, and tomatoes; diseases of plants—diseases of beans, potatoes, sweet potatoes, and other garden vegetables; food and nutrition of man; diseases of animals; entomology—study of mosquitoes and methods of eradicating them, study of the rose scale, orchard insects, and the use of insecticides; dairy husbandry—breeding up a dairy herd, study of domestic pasteurizing methods and the care of milk in the home, feeding dairy cows, including the investigation of legumes as substitutes for purchased feeds; bacteria of soils, and irrigation.

INCOME.

The income of the stations during the past fiscal year was as follows:

State station: State appropriation (fiscal year ended October 31, 1903)	\$24, 500
College station: United States appropriation	15, 000
Total	39, 500

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of these stations received during the past fiscal year were Bulletins 157-163, Special Bulletin T on Salt Marsh Mosquito, and the Annual Report for 1902. Bulletin 161 gives the result of investigations with alfalfa, cowpeas, and crimson clover as substitutes for purchased feeds. In the case of alfalfa hay versus purchased feeds the investigation showed that while more milk was produced on the feed ration the alfalfa ration was more profitable and resulted in a greater gain in live weight. Similar results were secured in the comparison of crimson-clover hay with purchased feeds, and in the comparison of cowpea hay, silage, and crimson-clover hay with purchased feeds the conclusion was drawn that the home-grown ration was equally as good as the ration containing purchased feed. Bulletins were also published

on field experiments with nitrate of soda on market-garden crops, soil-ing-crop experiments, the rose scale, concentrated feeding stuffs, and the lime-salt-sulphur wash.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, Mesilla Park.

Department of New Mexico College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Regents: Granville A. Richardson (*President*), *Roswell*; H. B. Holt (*Secretary and Treasurer*), *Las Cruces*; Seaman Field, *Deming*; W. A. Cooper, *Santa Fe*; José Lucero, *Las Cruces*. Advisory Members: Governor Miguel A. Otero, *Santa Fe*; J. Francisco Chaves (*Superintendent of Public Instruction*), *Santa Fe*.

STATION STAFF.

Luther Foster, M. S. A., <i>Director</i> .	R. Fred Hare, M. S., <i>Chemist</i> .
J. J. Vernon, M. S. AGR., <i>Agriculturist</i> .	C. L. Post, M. S., <i>Assistant Chemist</i> .
E. O. Wooton, M. A., <i>Botanist</i> .	H. C. McLallen, M. S. AGR., <i>Assistant</i>
J. D. Tinsley, B. S., <i>Vice-Director; Soils,</i>	<i>Agriculturist</i> .
<i>Meteorologist</i> .	J. M. Scott, B. S., <i>Assistant Agriculturist</i>
Fabián García, B. S., <i>Horticulturist</i> .	F. E. Lester, <i>Registrar</i> .
Pinckney Ford, <i>Stenographer</i> .	

GENERAL OUTLOOK.

During the past fiscal year the New Mexico Station has made progress in systematizing its work and grouping it around irrigation as the most important line of investigation. The experiments of the station on pumping for irrigation have attracted more attention than any other line of work that has been taken up. A number of problems have been attacked. It was necessary to determine whether the volume of water was sufficient, also the size of bore and depth of wells, the best kind of pump, the best type of engine, and the cheapest fuel. The past year's work has been given mainly to the determination of the best kind of pump and the best type of engine. Some attention has also been given to a drainage experiment to remove the alkali in Pecos Valley. The undertaking has not been entirely successful, but much interest is aroused and the work is to be undertaken on another plan. The horticulturist has done considerable work with ornamentals and is giving some attention to problems in growing onions and potatoes. It has been claimed that potatoes could not be grown in the Mesilla Valley, but an effort is being made to secure varieties that will succeed. Much attention is being given to alfalfa and other legumes, not only for forage purposes but also for the purpose of improving the mechanical condition of the soil. Some tobacco work has been done, assistance being rendered by the owner of a tobacco factory in Albuquerque, who furnished the plants. The station has cooperated also with farmers in the vicinity of Mesilla Park in spray-

ing for fruit pests in commercial orchards. With this Department the station has cooperated as follows: With the Division of Entomology in investigations on the codling moth; with the Bureau of Plant Industry in investigations on the growth of fruit trees and the introduction of leguminous crops, and with the Bureau of Chemistry in the study of available plant food in soils.

Farmers' institute work was organized during the year and a number of successful meetings were held under the auspices of the college. The station staff was increased by the addition of an assistant to the agriculturist. The chemist resigned to become director of the Indiana Station and was succeeded by his assistant. The equipment of several of the departments was improved by the addition of a number of implements and pieces of scientific apparatus. In addition to the regular bulletins, a large number of press bulletins were issued on popular topics. The Territorial tax levy for the support of the college has been increased, so that it now yields about \$15,000 per annum, and it is expected that a readjustment of assessments will increase this amount. It is hoped that the station, which is now coming into close touch with the people of the State and is meeting with their approval, will share in the more liberal funds thus provided. As it is now organized and equipped the station is in better condition than ever before.

LINES OF WORK.

The principal lines of work conducted at the New Mexico Station during the past year were as follows: Chemistry—chemical survey of the waters of the Territory, analytical work, study of the ash of native plants; field experiments—alfalfa, grasses for lawns and pastures, cereals, soil renovators, forage crops; soils; feeding experiments with dairy cows, steers, and sheep to test the value of various grains and forage crops for soiling and for dry feed; horticulture—culture, pruning, spraying, and irrigation of orchard, vineyard, and small fruits, vegetable culture, tests of shrubs, flowers, and forage trees; botany—preparation of botanical map of the Territory, range problems; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation.....	750.00
Farm products.....	1,865.91
Total.....	<u>17,615.91</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 41-43 and the Annual Report for 1902. The subjects of the bulletins are spraying orchards for the codling moth, alkali, and drainage and flooding for the removal of alkali.

NEW YORK.

New York Agricultural Experiment Station, Geneva.

GOVERNING BOARD.

Board of Control: Stephen H. Hammond (*President*), Geneva; W. O'Hanlon (*Secretary and Treasurer*), Geneva; Gov. Benj. B. Odell, jr., Albany; Jens Jensen, Binghamton; Thos. B. Wilson, Halls Corners; F. C. Schraub, Lowville; C. Willis Ward, Queens; Edgard G. Dusenbury, Portville; Milo H. Olin, Perry; Irving Rouse, Rochester; Lyman P. Haviland, Camden.

STATION STAFF.

W. H. Jordan, D. Sc., <i>Director</i> .	F. D. Fuller, B. S., <i>Assistant Chemist</i> .
G. W. Churchill, <i>Agriculturist, Superintendent of Labor</i> .	C. W. Mudge, B. S., <i>Assistant Chemist</i> .
W. P. Wheeler, <i>Animal Industry</i> .	A. J. Patten, B. S., <i>Assistant Chemist</i> .
H. A. Harding, M. S., <i>Bacteriologist</i> .	G. A. Smith, <i>Dairy Expert</i> .
M. J. Prucha, PH. B., <i>Assistant Bacteriologist</i> .	F. H. Hall, B. S., <i>Editor and Librarian</i> .
F. C. Stewart, M. S., <i>Botanist</i> .	P. J. Parrott, M. A., <i>Entomologist</i> .
H. J. Eustace, B. S., <i>Assistant Botanist</i> .	S. A. Beach, M. S., <i>Horticulturist</i> .
L. L. Van Slyke, PH. D., <i>Chemist</i> .	V. A. Clark, B. S., <i>Assistant Horticulturist</i> .
E. B. Hart, B. S., <i>Associate Chemist</i> .	O. M. Taylor, <i>Foreman in Horticulture</i> .
C. G. Jenter, ^a PH. C., <i>Assistant Chemist</i> .	F. E. Newton, <i>Clerk and Stenographer</i> .
W. H. Andrews, B. S., <i>Assistant Chemist</i> .	Jennie Terwilliger, <i>Clerk and Stenographer</i> .
	A. H. Horton, <i>Computer</i> .

GENERAL OUTLOOK.

Aside from the inconveniences caused by the burning of its barns, the work of the New York State Station has progressed satisfactorily during the past year. Some of the completed lines of work are as follows: A study of phosphorus in feeding stuffs, showing that there was no inorganic phosphorus in the feeds examined; a study of the rôle of lactic-acid bacteria in the early stages of cheese ripening, and the development of a method for the control of rusty spot in cheese factories; the determination of the nature of the Cephalothecium rot of the apple and of a remedy for it; a test of the removal of affected leaves for the treatment of cabbage rot, which has proven ineffective; studies of cheese ripening showing the existence of acid salts of paracasein and casein, thus giving an explanation of many features in the process of ripening Cheddar cheese; the elaboration of methods for the estimation of proteolytic compounds in milk and cheese; the dis-

^aOn leave.

covery that a considerable part of the ripening of cheese is due to peptic digestion of the paracasein salt, the pepsin being introduced in the rennet; the establishment of the lime-sulphur-salt wash as a thoroughly practical and efficient insecticide. The station has inaugurated a large amount of new work with cheese and other dairy products, has begun to study the metabolism of phosphorus and sulphur in the cow and hen, and is giving considerable attention to the growing of seed with reference to vitality, and the shading of horticultural plants, particularly strawberries.

The cooperative work with farmers has included a test of forage and soiling crops on Long Island; tests of spraying for potato scab and rot, raspberry cane blight, and cauliflower and cabbage black rot; experiments in the use of grape stocks and apple stocks, shading strawberries, growing chestnuts, storing apples, and the use of the lime-sulphur-salt wash. The cheese-curing investigations in cooperation with the Bureau of Animal Industry of this Department have been continued, also the growing of sugar-beet seed with the Bureau of Plant Industry, sugar-beet investigations with the Bureau of Chemistry, and investigations of the San José scale and Asiatic ladybird with the Division of Entomology. In cooperation with the Vermont Station, a study of soft rot of cabbage and cauliflower has been undertaken. The inspection work of the station with fertilizers, feeding stuffs, Paris green, insecticides, and Babcock-test glassware has been continued.

This station is doing work of a high scientific order and of great practical usefulness. Not only is it conducting a large amount of thoroughly scientific work which is likely to take years for completion, but it is also attacking many problems capable of immediate solution, and is carrying the results of these investigations directly to the farmer through its publications, its cooperative work, and the participation of its officers in farmers' institute work. Nearly all the heads of departments take part in the farmers' institute work of the State, and this year the station is to cooperate with Cornell University in giving a normal institute for institute workers. At this meeting the regular institute workers of the State will assemble for two weeks to receive instruction by means of lectures and otherwise on the most prominent features of station work and on the best way of presenting the results of the station investigations to the people in the institutes.

LINEs OF WORK.

The principal lines of work conducted at the New York State Station during the past year were as follows: Chemistry—study of problems in cheese ripening, of changes in milk, and of fertilizers and feeding stuffs; bacteriology—study of problems in cheese ripening, tests of methods for the repression of rusty spot in cheese; meteorology; fer-

tilizers—study of the proportions and forms of fertilizing ingredients best suited to the staple crops of the State; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments—tests of commercial fertilizers and stable manure on crops in rotation, study of crops grown on soils treated with crude chemicals, and cooperative tests of forage and soil-renovating crops, variety tests of cowpeas and wheat, growth of mother beets to test the possibility of raising sugar-beet seed; horticulture—study of the cause and effect of self-sterility among grapes, effect of fertilizers on the quality of strawberries and bush fruits, tests of various stocks for native grapes and for dwarf apples, comparison of American and Japanese chestnuts, use of screens for shading strawberries, experiments with apples in cold storage, breeding of grapes, raspberries, currants, gooseberries, and strawberries, test of lettuce fertilizers in the greenhouse, systems of fertilizing apple orchards, study of forcing tomatoes with reference to frequency of pollination required, collection of data to determine the significance of correlation of parts as a factor in plant breeding; diseases of plants—investigations and experiments in the treatment of raspberry and blackberry diseases, especially cane blight, study of diseases of apples, ten-year test of the efficiency of spraying potatoes to prevent disease and to increase yield, test of repressive measures for black rot of cabbage and cauliflower, with investigation of soft rot of the same plants, study of *Rhizoctonia* as a cause of plant diseases; feeding experiments; poultry experiments—study of the effect and value of different classes of nutrients in poultry feeding and of inbreeding and selection as affecting egg production; entomology—biological study of the San José scale and the development of a successful and convenient method for controlling this insect, experiments on the fertilization of fruit by bees, study of the economic relations of *Dactylopius*; dairying; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$1,500. 00
State appropriation.....	90,258. 16
Insurance.....	7,304. 55
Total.....	<hr/> 99,062. 71

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 213-232 and the Annual Report for 1901. The subjects treated in these bulletins are as follows: Treatment for San José scale

in orchards (spraying with kerosene and crude petroleum); a study of some of the salts formed by casein and paracasein with acids; methods for the estimation of the proteolytic compounds contained in cheese and milk; report of analyses of commercial fertilizers for the spring and fall of 1902; inspection of feeding stuffs; variety test of strawberries (with popular edition); some of the compounds present in American Cheddar cheese; two universal troubles of apple foliage (with popular edition); potato spraying experiments in 1902; report of analyses of Paris green and other insecticides in 1902; investigations concerning the self-fertility of the grape, 1900-1902; III, a study of grape pollen (with popular edition); control of rusty spot in cheese factories (with popular edition); raspberry cane blight and raspberry yellows (with popular edition); San José scale investigations, IV (with popular edition); a destructive apple rot following scab (with popular edition); director's report for 1902; some facts about commercial fertilizers in New York State; the relation of carbon dioxide to proteolysis in the ripening of Cheddar cheese; combating the black rot of cabbage by the removal of affected leaves (with popular edition).

Cornell University Agricultural Experiment Station, Ithaca.

Department of Cornell University.

GOVERNING BOARD.

Board of Trustees—Station Council: Jacob G. Schurman (*President of the University*), Franklin C. Cornell, Liberty H. Bailey, Emmons L. Williams (*Treasurer of the University*), John H. Comstock, and Thomas F. Hunt.

STATION STAFF.

L. H. Bailey, M. S., <i>Director.</i>	J. L. Stone, B. S. A., <i>Assistant Agronomist.</i>
G. C. Caldwell, B. S., PH. D., <i>Chemist.</i>	Samuel Fraser, <i>Assistant Agronomist.</i>
J. H. Comstock, B. S., <i>Entomologist.</i>	R. S. Northrop, B. S., <i>Assistant Horticulturist.</i>
H. H. Wing, B. AGR., M. S., <i>Animal Husbandman.</i>	J. M. Van Hook, M. A., <i>Assistant Plant Pathologist.</i>
G. F. Atkinson, PH. B., <i>Botanist.</i>	H. H. Whetzel, B. A., <i>Assistant Plant Pathologist.</i>
John Craig, M. S., <i>Horticulturist.</i>	J. W. Gilmore, B. S. A., <i>Assistant Agronomist.</i>
T. F. Hunt, M. S., <i>Agronomist.</i>	J. A. Bizzell, <i>Assistant Chemist.</i>
R. A. Pearson, M. S., <i>Dairy Industry.</i>	S. W. Fletcher, M. S., PH. D., <i>Assistant Horticulturist.</i>
J. A. Bonsteel, PH. D., <i>Soil Investigations.</i>	J. M. Trueman, <i>Assistant Animal Husbandman, Dairy Industry.</i>
M. V. Slingerland, B. S., <i>Assistant Entomologist.</i>	E. A. Butler, <i>Clerk.</i>
G. W. Cavanaugh, B. S. A., <i>Assistant Chemist.</i>	Lizzie V. Maloney, <i>Stenographer.</i>
J. E. Rice, B. S. A., <i>Poultry Husbandman.</i>	
C. E. Hunn, <i>Assistant Horticulturist.</i>	

GENERAL OUTLOOK.

The New York Cornell Station has continued its investigations along nearly the same lines as formerly, giving prominence on the one hand to problems of immediate practical importance, and on the other to

the solution of a number of scientific problems of general importance. In chemistry an investigation has been made of the effect of formalin on the albumin in milk with results which may have an important bearing on the relation of formalin as a preservative to the digestibility of milk. Other preservatives will be investigated. Studies have been made of fermentation in the silo, the pink rot of apples, diseases and culture of ginseng, and a number of insects of the vineyard and orchard. The work in animal husbandry has been a continuation of feeding experiments with dairy cows and poultry. Regarding the latter work three bulletins have been published on the cost of egg production. The new Danish system of milking has been under trial and results have been published. Cooperative work with farmers has been continued along several lines in agronomy and in horticulture, the latter being concerned principally with insects in the vineyard, cover crops, and the use of cheese-cloth shades for the growing of various crops. The station has cooperated with the Bureau of Chemistry of this Department in sugar-beet investigations.

The Cornell Station is undergoing a complete reorganization under the management of the new director, who took charge July 1, 1903. It is the policy of the new management to organize several strong departments, with more complete equipment and greater independence of action than formerly existed. Already departments of agronomy, animal husbandry, dairying, soils, horticulture, and poultry husbandry have been more or less fully organized. At the same time the courses of study in the college of agriculture are being developed and strengthened, and agriculture will share equally with mechanic arts in the land-grant and Morrill funds. The school of forestry in the college has been discontinued, owing to the failure of the last legislature to make appropriation for its support. With a strong staff of specialists, and with prospects for greatly improved facilities, the outlook for investigations of a high character at the Cornell Station are very encouraging.

LINES OF WORK.

The principal lines of work conducted at the Cornell Station during the past year were as follows: Chemistry—study of soils, feeding stuffs, dairy products, insecticides, causes of injury to foliage by Bordeaux mixture; fertilizers; field experiments—tests of rotations, legumes, and fertilizers, tillage and fertilizer experiments with potatoes, beans, buckwheat, etc., plot experiments with grasses; horticulture—forcing strawberries, tree fruits, and mushrooms, studies of Japanese plums and methods of spraying; diseases of plants—fungus diseases of forest and shade trees, study of the rôle of fungi in rendering available the plant food in dead wood, study of edible fungi and of

numerous fungus and bacterial diseases of vegetables; feeding experiments—dairy cows, sheep, and swine; diseases of animals; poultry experiments—crossing of breeds, experiments in the cost of egg production and on the effect of early molting on laying in the early fall and winter; entomology—study of the life history of several economic insects, spraying experiments; and dairying—relation of feed to fat content of milk, bacteriological study of the germicidal action in milk, study of fermentation in condensed milk.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$13,500.00
State appropriation.....	a19,833.34
Total	33,333.34

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 202-210 and the Annual Report for 1902. The following are the subjects of the bulletins: Trap lanterns, or "moth-catchers;" the care and handling of milk; cooperative experiments on the cost of egg production; shade trees; sixth report of extension work; pink rot—an attendant of apple scab; the grape root worm or grapevine fidia; distinctive characteristics of the species of the genus *Lecanium*, commercial bean growing in New York.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

S. L. Patterson, *Commissioner of Agriculture (Chairman), Raleigh.*

Board of Agriculture: John M. Forehand, *Rockyhook*; J. B. Stokes, *Windsor*; William Dunn, *Newbern*; C. N. Allen, *Auburn*; R. W. Scott, *Melville*; A. T. McCallum, *Red Springs*; J. P. McRae, *Laurinburg*; R. L. Doughton, *Laurel Springs*; W. A. Graham, *Machpelah*; A. Cannon, *Horseshoe*.

^a This is approximately the amount spent for experimental purposes out of an appropriation of \$35,000 by the State for cooperative experiments and university extension work in agriculture.

STATION STAFF.

B. W. Kilgore, M. S., <i>Director.</i>	F. L. Stevens, M. S., PH. D., <i>Biologist.</i>
W. A. Withers, M. A., <i>Chemist.</i>	W. G. Morrison, M. A., <i>Assistant Chemist.</i>
C. W. Burkett, M. S., PH. D., <i>Agriculturist.</i>	J. C. Kendall, B. S., <i>Assistant in Dairying.</i>
W. F. Massey, C. E., <i>Horticulturist.</i>	J. S. Jeffrey, <i>Poultryman.</i>
Tait Butler, D. V. S., <i>Veterinarian.</i>	B. S. Skinner, <i>Farm Superintendent.</i>
Franklin Sherman, jr., B. S. A., <i>Entomologist.</i>	B. F. Walton, <i>Superintendent of Agricultural Experimental Work.</i>
A. F. Bowen, <i>Bursar.</i>	

GENERAL OUTLOOK.

The work of the North Carolina Station has been continued along nearly the same lines as formerly. The poultry work has been considerably extended by the purchase of additional breeding stock and the erection of houses for their accommodation and for experiments with them. The nitrification experiments with different soils and fertilizer materials have been continued, together with the study of methods for determining the nitrifying power of different soils. This work is conducted with great care and skill and reflects credit upon the station. A new feeding-stuffs inspection act was passed by the last legislature and the State board of agriculture has employed a chemist who will have special charge of the work and will conduct microscopic studies of feeds and their adulterants. The biologist is making a careful study of a wilt disease of tobacco which has been present in the State for at least two years. During the past year he cooperated with the Bureau of Plant Industry of this Department and the State department of agriculture in a study on the black rot of the grape and the results have been published as a station bulletin. Some cooperative work is also being done with the Bureau of Soils in making a soil survey, with the Bureau of Chemistry on the available plant food in soils, with the Division of Entomology on the San José scale and the Asiatic ladybird, and with farmers in preventing the smut of grain.

The North Carolina Station and the State department of agriculture continue to work together harmoniously and effectively, and the assistance of the latter materially strengthens the work of the station in the State. The department now maintains three experimental farms, which are attracting much attention from the farmers, many of whom come long distances to see them. The work of these farms consists largely of variety, cultural, fertilizer, and other tests with cotton, corn, peanuts, tobacco, and grain, and experiments with grasses and forage crops and stock. About \$5,000 was used for this work during the past year. The department still conducts on a somewhat larger scale the inspection work in entomology and quarantine work with Texas

fever. The veterinarian's efforts are directed largely toward clearing the country of Texas fever ticks in the effort to move the quarantine line farther south. The mailing list of the station has grown in four years from 6,000 to about 27,000, although the intention has been to enter the names of only such persons as request the bulletins and are likely to make use of them. The correspondence of the station has also increased greatly and is now very large. It is evident that the station has a strong hold on the people and they are appealing to it in many ways. The farmers' institute work is very popular and the demand now is for the better class of speakers who have a thorough grounding in the science of agriculture and can base their talk on experiment or the latest development in agriculture. With such evidence of confidence in the station and with the cordial relations existing between the different agencies for the promotion of agriculture in the State the outlook for the station is very promising.

LINES OF WORK.

The principal lines of work conducted at the North Carolina Station during the past year were as follows: Chemistry—rate of nitrification of different nitrogenous substances in different soils, methods of analysis; soils; field experiments—variety, cultural, and fertilizer tests with cotton, corn, and cowpeas, experiments with grasses and forage plants; horticulture; plant diseases; animal husbandry—beef production, feeding work horses; diseases of animals; poultry experiments, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	^a 5,000.00
Farm products and miscellaneous.....	2,883.70
Total	22,883.70

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 181-183 and the Annual Report for 1901. The bulletins include reports on silk culture, the apple, and insect and fungus enemies of the apple, pear, and quince, with methods of treatment.

^a Approximate amount spent for experimental purposes.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College*.

Department of North Dakota Agricultural College.

GOVERNING BOARD.

Board of Trustees: Alex. Stern (*President*), *Fargo*; J. D. Moulder, *Fargo*; Maynard Crane, *Cooperstown*; B. N. Stone, *Lamoure*; L. B. Hanna (*Treasurer*), *Fargo*; S. S. Lyon (*Secretary*), *Fargo*; Addison Leech, *Warren*; Chas. McKissick, *Mayville*.

STATION STAFF.

J. H. Worst, LL. D., <i>Director</i> .	Hugh McGuigan, B. S., <i>Assistant</i>
E. F. Ladd, B. S., <i>Chemist</i> .	<i>Chemist</i> .
C. B. Waldron, B. S., <i>Horticulturist, Entomologist</i> .	L. R. Waldron, M. A., <i>Assistant Botanist</i> .
H. L. Bolley, M. S., <i>Botanist</i> .	L. Van Es, M. D., V. S., <i>Veterinarian</i> .
J. H. Sheppard, M. S. A., <i>Agriculturist</i> .	Nicholas Grest, <i>Farm Foreman</i> .
J. C. McDowell, B. Agr., <i>Assistant Agriculturist</i> .	C. E. Nugent, <i>Secretary</i> .
	O. A. Thompson, <i>Superintendent of Edgeley Substation</i> .

GENERAL OUTLOOK.

The North Dakota Station has made but few changes in the lines of work pursued. The chemist and agriculturist have undertaken experiments with wheat to determine to what extent the gluten content can be modified or increased by selection and cultivation. The botanist has continued to give much attention to investigations of diseases of flax and methods of controlling the same. Besides devising different means for treating flaxseed to eradicate the disease, he has developed by selection a strain of flax which is said to be immune to the flax-wilt disease. He is also selecting and breeding flax for frost-resistant, early-ripening, and late-ripening qualities. At the present time he is in Europe making an investigation of flax diseases, varieties of flax, etc., for the North Dakota Station and this Department. The agriculturist of the station is carrying on investigations with harvesting machinery to study the effect of exposure upon the length of time that the machinery will last, and upon the expenditure necessary to keep it in repair during its period of usefulness.

The station is cooperating with a committee of the Tri-State Grain Growers' Association in studying the value of macaroni flour, and with this Department, as follows: With the Bureau of Plant Industry in the investigation of cereals, forage plants, and other crops, the introduction of improved varieties of flax, and studies on the influence of origin of red-clover seed on yield of crop; with the Bureau of Chemistry in studying the available plant food in soils, and with the Bureau of Soils in a soil survey. It is making a plant survey of the State in conjunction with a geological survey. The agriculturist of the station, as president of the farmers' institute board, has spent considerable time in the farmers' institute work, as have also one or two other members of the

station staff. The substation at Edgeley is supported by a State appropriation of \$5,000. The experiments there consist largely of field tests of crops to secure varieties suited to the regions of the State having light soils and small rainfall.

The North Dakota Station has considerable work in hand which is of much importance to the agriculture of the State. It has now determined the agricultural conditions in the State sufficiently to be in position to undertake work of much greater moment provided sufficient funds are placed at its command. It is especially in need of funds for experimental investigations in animal industry, dairying, and farm mechanics, and it is to be hoped that the State will adopt a more liberal policy toward the station.

LINES OF WORK.

The principal lines of work conducted at the North Dakota Station during the past year, were as follows: Chemistry—investigation with soils and fertilizers, study of gluten content of selected wheats, and of plant food in soils; botany—studies of grasses and forage plants and noxious and poisonous weeds, seed control; field experiments—rotations, methods of culture, tests of hardy varieties of cereals and forage plants, selection of seed, selection and improvement of potatoes, sugar beets, corn, clover, alfalfa, and other farm crops; plant breeding—cereals; horticulture—variety tests of native plums and other fruits and of vegetables, experiments with forest trees; analysis of foods; diseases of plants—flax wilt, asparagus rust; animal husbandry—feeding experiments with horses, mules, sheep, and pigs, and tests of the comparative feeding value of brome grass and timothy; diseases of animals; dairying; tests of farm machinery.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products.....	3,044.44
Miscellaneous.....	428.23
Balance from previous year.....	48.99
Total.....	18,521.66

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 52-55 on the length of the growing season in North Dakota, food products and their adulteration, abortion in cattle, scours in new-born calves, and flax and flaxseed selection; Special Bulletin No. 2 on weeds, and the Annual Report for 1902.

OHIO.

Ohio Agricultural Experiment Station, Wooster.

GOVERNING BOARD.

Board of Control: Alva Agee (*President*), *Cheshire*; O. E. Bradfute (*Secretary*), *Xenia*; D. L. Sampson (*Treasurer*), *Cincinnati*; F. A. Derthick, *Mantua*; D. D. White, *Custalia*.

STATION STAFF.

C. E. Thorne, M. S. A., <i>Director</i> .	C. A. Patton, <i>Assistant Foreman; Meteorologist</i> .
W. J. Green, <i>Vice-Director; Horticulturist</i> .	Faye Blayney, <i>Mailing Clerk</i> .
C. G. Williams, <i>Agriculturist; Superintendent of Farm</i> .	Cary Welty, <i>Mechanician</i> .
A. D. Selby, Ph. D., <i>Botanist</i> .	J. L. Taggart, <i>Horticultural Foreman</i> .
J. W. Ames, B. S., <i>Chemist</i> .	F. W. Glass, <i>Printer</i> .
W. H. Kramer, <i>Bursar</i> .	Edward Mohn, <i>Superintendent of Substation (Strongsville)</i> .
G. M. Lummis, B. S. A., <i>Assistant Botanist</i> .	Lewis Schultz, <i>Superintendent of Substation (Germantown)</i> .
J. S. Houser, <i>Assistant Entomologist</i> .	H. M. Wachter, <i>Superintendent of Substation (Germantown)</i> .
C. W. Waid, B. S., <i>Assistant Horticulturist</i> .	
William Holmes, <i>Farm Foreman</i> .	

GENERAL OUTLOOK.

The leading feature of the work of the Ohio Station continues to be its well-planned and carefully conducted field experiments with fertilizers, various rotations, and varieties of cereals. Similar field work with tobacco fertilizers has recently been inaugurated, also fertilizer and inoculation experiments with legumes, experiments with cover crops sown in corn at its last cultivation, and feeding experiments with range steers for market. In horticultural lines, special attention is given to spring forcing of cucumbers, muskmelons, tomatoes, etc., and to comparative tests of clean culture, cover crops, and mulching for orchards. Comparative tests of trees for post timber are also in progress. Plans have been made for dividing the agricultural department, the present agriculturist to have charge of the field work at the station, and an animal husbandman, to be appointed, to take charge of experiments in animal production and have supervision of the test farms. The station has in hand a large amount of cooperative work, much of which is conducted through the agency of the Agricultural Student Union of Ohio. This includes spraying and orchard management and field experiments. The work of the station in cooperation with this Department includes studies of the influence of the origin of red-clover seed on yield of crop, with the Bureau of Plant Industry; available plant food in soils, with the Bureau of Chemistry; and investigations on the San José scale and Asiatic ladybird, with the Division of Entomology.

The station now maintains three test farms with the aid of a State

appropriation of \$10,000 for two years. Two of these farms were established during the past year—one at Carpenter, in the hilly regions of southeastern Ohio, and one at Germantown, in southwestern Ohio, where especial attention will be given to tobacco culture. The other test farm is at Strongsville, in northeastern Ohio. The northwestern test farm, located in Fulton County, has been abandoned. The station has installed a complete printing outfit with funds provided by the State. With the better conditions arising from the reorganization of the station and the appropriation of State funds for its partial support, the station is now in position to strengthen its scientific investigations and develop considerable work in animal husbandry, and might profitably use larger funds for these purposes.

LINES OF WORK.

The principal lines of work conducted at the Ohio Station during the past year were as follows: Soils; field experiments—fertilizer and rotation experiments with corn, oats, wheat, potatoes, tobacco, and leguminous crops, variety tests of cereals, experiments with cover crops; horticulture—cauliflower and other vegetables under cheese cloth, study of 175 varieties of plums, forcing tomatoes, lettuce, cucumbers, and muskmelons, variety tests of vegetables and fruits, orchard management; plant breeding and selection—corn and wheat; diseases of plants—Rhizoctonia in potatoes, onion smut, grape rot, diseases of ginseng and tobacco; breeding and feeding experiments with cattle; diseases of animals—bovine tuberculosis, stomach worms of sheep; and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
State appropriation, including balance from previous year.....	47,483.93
Fees.....	393.05
Farm products, including balance from previous year.....	5,862.78
Miscellaneous.....	1,959.96
Total.....	<hr/> 70,699.72

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 133, 134, 137, 138, and 140, the subjects being potatoes, the value of barnyard manure, experiments with oats, suggestions concerning apple culture, and the corn crop.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, Stillwater.

Department of Oklahoma Agricultural and Mechanical College.

GOVERNING BOARD.

Board of Regents: F. J. Wikoff (*President*), *Stillwater*; Governor T. B. Ferguson, *Guthrie*; H. G. Beard, *Shawnee*; T. J. Hartman (*Treasurer*), *Deer Creek*; H. C. R. Brodboll, *Ponca City*; W. H. Merten, *Guthrie*.

STATION STAFF.

John Fields, B. S., *Director; Chemist.*J. F. Nicholson, M. S., *Assistant Bacteriologist.*L. L. Lewis, M. S., D. V. M., *Veterinarian.*E. H. Riley, B. Agr., *Assistant Animal Husbandman.*F. C. Burtis, M. S., *Agriculturist.*O. M. Morris, B. S., *Horticulturist.*W. R. Shaw, Ph. D., *Botanist, Entomologist.*A. G. Ford, B. S., *Associate Chemist.*F. O. Foster, *Assistant Agriculturist.*L. A. Moorhouse, B. S. A., *Assistant in Soils and Crops.*W. C. Theile, *Clerk, Stenographer.*

GENERAL OUTLOOK.

Few changes have been made in the lines of work pursued by the Oklahoma Station during the past year. The investigations regarding Bermuda grass for pasture purposes have been summarized and published, as have also experiments with garden vegetables and in fattening steers with cotton seed, cotton-seed meal, wheat meal, wheat straw, and hay. The latter experiments resulted in much valuable information as to the value of cotton seed and wheat products and the limitations on their use as exclusive feed for fattening cattle. The results of a three-year experiment in feeding corn, Kafir corn, alfalfa hay, and Kafir stover to steers are being prepared for publication, also the results of experiments in feeding cotton-seed meal and wheat shorts to hogs. It will be seen that the station is giving much attention to forage crops and other feeds for live stock, which is one of the very important agricultural products of the Territory. The planting of trees by farmers for posts, fuel, and windbreaks has been a subject of investigation for six years, and results along this line are nearly ready for publication. The Hessian fly and the cotton boll weevil have recently appeared in the State, and are subjects of investigation by the entomologist. Studies of the chemical composition of Kafir corn, begun several years ago but dropped for lack of facilities, have been resumed. The horticulturist is working on a disease of the apple known as woolly root, the cause of which is unknown, and is carrying on some work with apricots, apples, and small fruits. A little work with poultry is being taken up in a preliminary way, and also some with sheep. The veterinarian is studying hog cholera with the hope

of securing attenuated cultures. One has been secured which works with rabbits but not with hogs. In this connection it is worthy of note that the State has recently made an appropriation of \$2,500 per annum for the manufacture and free distribution of vaccine for the prevention of blackleg in cattle, which relieves the station funds of this burden.

The college has recently bought 160 acres adjoining the old college farm, which will be available for the use of the station and will be a great help in the beef and pasturage experiments, relieving the station of the necessity of hiring pasture at a distance. Farmers' institutes in the Territory, which were organized largely under the initiative of the station director and other officers, have been placed under the secretary of a board of agriculture recently organized, and the expense of conducting them will be met from funds controlled by the board. The station will now economize its efforts in the institute work by going only to the principal county institutes. New assistants in agronomy, animal husbandry, and bacteriology have been appointed on the station staff, and accommodations for the entomologist and botanist have been provided in the new addition to the library.

The courses of study in the college have been reorganized. A school of agriculture and domestic science admitting pupils without examination has been established to take the place of the preparatory courses. In this school provision is made for more agriculture and allied subjects than was possible in the preparatory courses. The school course leads up to the subfreshman year in the college which has been put in for the purpose of raising the requirements in the regular college course one year.

The Oklahoma Station is making good progress in the line of development, and is strengthening its position with the farmers of the Territory by doing work especially adapted to their immediate needs. In return, the farmers are loyally supporting the station. The appropriation for the distribution of vaccine was secured by the active canvass of farmers, and was the first real evidence of their interest in the station. The demands upon the station are growing in extent and importance every year. The mailing list now contains over 19,000 names, and yet the funds available for printing will allow an edition of only 20,000 bulletins. Although the work is well systematized and the funds are handled in a very economical manner, they are not adequate for the payment of such salaries as will secure and keep the best investigators and capable assistants. Neither is the station suitably provided with laboratories for the departments of agriculture, chemistry, and horticulture, or office room for the officers. It needs additional funds for printing, for buildings, and for the extension of important lines of investigation.

LINES OF WORK.

The principal lines of work conducted at the Oklahoma Station during the past year were as follows: Chemistry; field experiments—cereals, pasture, and forage crops, continuous cropping, rotation experiments, potatoes; horticulture; forestry; diseases of plants; botany; improvement of the castor bean and cotton; animal husbandry; feeding experiments; diseases of animals—blackleg, parasites, dips, loco diseases; and entomology—Hessian fly, cotton-boll weevil, and melon louse.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Farm products, including balance from previous year.....	3,538.82
Total	18,538.82

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 53-57 on common parasites of domestic animals, the improvement of the castor plant, Bermuda grass, garden vegetables, directions for using vaccine for the prevention of blackleg in cattle, and the Annual Report for 1902.

OREGON.

Oregon Experiment Station, *Corvallis*.

Department of Oregon State Agricultural College.

GOVERNING BOARD.

Board of Regents: J. K. Weatherford (*President*), *Albany*; J. T. Apperson, *Park Place*; John D. Daly (*Secretary*), *Portland*; B. F. Irvine (*Treasurer*), *Corvallis*; W. E. Yates, *Corvallis*; Governor George E. Chamberlain, *Salem*; F. I. Dunbar (*Secretary of State*), *Salem*; J. H. Ackerman (*State Superintendent of Public Instruction*), *Salem*; W. P. Keady, *Portland*; Benton Killin, *Portland*; J. M. Church, *Lagrande*; John D. Olwell, *Centralpoint*; B. G. Leedy, *Tigardville*.

STATION STAFF.

James Withycombe, M. Agr., <i>Director</i> ;	H. D. Gibbs, B. S., <i>Assistant Chemist</i> .
<i>Agriculturist</i> .	C. M. McKellips, M. S., Ph. C., <i>Assistant Chemist</i> .
George Coote, <i>Florist, Gardiner</i> .	F. L. Kent, B. S. Agr., <i>Assistant Agriculturist, Dairyman</i> .
A. B. Cordley, M. S., <i>Entomologist</i> .	E. F. Pernot, M. S., <i>Bacteriologist</i> .
E. R. Lake, M. S., <i>Horticulturist, Botanist</i> .	T. H. Crawford, M. A., <i>Clerk, Purchasing Agent</i> .
A. L. Knisely, M. S., <i>Chemist</i> .	
F. E. Edwards, B. M. E., <i>Assistant Chemist</i> .	
J. F. Fulton, B. S. Agr., <i>Assistant Chemist</i> .	
	Helen L. Holgate, <i>Stenographer</i> .

GENERAL OUTLOOK.

There have been few changes in the work of the Oregon Station during the past year. In the Department of Agriculture problems of rotation and the growing of forage plants have continued to occupy the leading position. Alfalfa has been grown with marked success in the western part of the State, yielding as high as 18 tons of green forage per acre. The investigations with steamed silage did not show such good results with clover and vetch as with corn. In the feeding experiments excellent results were obtained from soiling dairy cows, and also from feeding skim milk with wheat for fattening swine. In dairying the effects of feeding varying amounts of silage upon the yield of milk, butter fat, and body weight were tested, also the efficiency of hand separators under farm conditions. The chemical department continued its studies of steamed silage, soils, hop and fruit drying, and fertilizers, and has begun studies on protein in vetch hay and the use of lime in the straw heap as affecting decomposition. The entomologist is studying diseases and insects affecting fruits and grains, and the effect of free arsenious acid in Paris green on foliage. The horticulturist has devoted considerable attention to the dates of blooming and ripening of apples and pears. His work with onions shows marked results in favor of starting the seed in boxes and transplanting. The bacteriologist has closed a series of experiments testing the value of different methods of treating grain for the prevention of smut. Copper sulphate, formaldehyde, hot water, and hot, dry air were tested with results showing the greatest efficiency in destroying spores and the least injury to the germinating qualities of the seed in the use of hot, dry air. He has also obtained encouraging results in curing cheese in sealed cans with the aid of pure cultures. The fresh curd containing pure cultures is placed in tin cans, pressed over night in a cheese press, and the covers then soldered on. The ripening process is said to result in a cheese of superior and quite uniform flavor, and of a more friable and waxy texture than ordinary cheese, without rind or danger of mold.

The station has cooperated in the past year with about 100 farmers in different parts of the State in experiments with cereals and forage plants; with this Office in irrigation investigations; with the Bureau of Plant Industry in studying the influence of origin of red-clover seed on yield of crop; with the Bureau of Chemistry in studying available plant food in soils, and with the Division of Entomology in studying the San José scale and the Asiatic ladybird. The work at Moro, in eastern Oregon, will soon be suspended. The station at Union, which is supported by a biennial appropriation of \$20,000 from the State, has continued to devote its work mainly to investigations with grasses and forage plants. This station is cooperating with the Bureau of Chemistry of this Department in sugar-beet investigations.

The operations of the Oregon Station are considerably cramped for lack of sufficient funds. An arrangement has been made recently by which some relief is brought about through a readjustment of salaries, but there is still need of additional funds for work in animal husbandry. The station is becoming increasingly popular throughout the State and is producing marked effects on agricultural practice.

LINES OF WORK.

The principal lines of work conducted at the Oregon Station during the past year were as follows: Chemistry—analytical work, investigations with silage, fertilizers for prune trees, lime in straw heaps, plant food in soils, experiments in drying hops and evaporating prunes and apples, soils; field crops—rotations, variety tests of cereals, grasses, and other forage crops, fertilizer tests; horticulture; diseases of plants; digestion and feeding experiments with dairy cows and swine, including soiling experiments with both; entomology, and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Farm products, including balance from previous year	1,445.64
Total	16,445.64

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 70-75 and the Annual Report for 1902. The following subjects were treated in the bulletins: Testing milk and cream, stagnant water germs in milk, steamed silage, vinegar making, the cultivation of vegetables, and insecticides and fungicides. The annual report included a financial statement, the director's annual report, and reports from the different departments, including special articles on experiments with gypsum on clover and vetch, foot-rot of wheat, and a bacterial blight of strawberries.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station,
State College.

Department of the Pennsylvania State College.

GOVERNING BOARD.

Board of Trustees—Advisory Committee: John A. Woodward (*Chairman*), *Howard*; W. F. Hill, *Westford*; H. V. White, *Bloomsburg*; George W. Atherton, *State College*; H. P. Armsby (*Secretary*), *State College*.

STATION STAFF.

H. P. Armsby, Ph. D., <i>Director.</i>	J. A. Fries, B. S., <i>Assistant in Animal Nutrition.</i>
William Frear, Ph. D., <i>Vice-Director; Chemist.</i>	T. M. Carpenter, B. S., <i>Assistant Chemist.</i>
W. A. Buckhout, M. S., <i>Botanist.</i>	M. H. Pingree, B. S., <i>Assistant Chemist.</i>
G. C. Butz, M. S., <i>Horticulturist.</i>	H. L. Wilson, B. S., <i>Assistant Chemist.</i>
G. C. Watson, B. Agr., M. S., <i>Agriculturist.</i>	W. M. Darrow, <i>Assistant Chemist.</i>
W. C. Patterson, <i>Farm Superintendent.</i>	J. Plummer Pillsbury, <i>Assistant Horticulturist.</i>
Julia C. Gray, <i>Secretary, Librarian.</i>	A. K. Risser, <i>Assistant Agriculturist.</i>
H. D. Edmiston, <i>Laboratory Assistant.</i>	

GENERAL OUTLOOK.

The Pennsylvania Station has continued most of the investigations that were in progress at the time of the last report, and has published some results which have attracted considerable attention. This is especially true of the reports of experiments on milk substitutes for calves, and the experiments in ginseng culture. The latter experiments have shown on the one hand the possibility of securing large returns from ginseng culture when carried on skillfully and painstakingly, and, on the other hand, they have served to demonstrate the exaggerated claims made by those who have seeds or plants to sell. In the division of animal nutrition attention has been centered on work in cooperation with the Bureau of Animal Industry of this Department with the respiration calorimeter, which has been brought to a high degree of perfection. After a number of very satisfactory preliminary tests, actual trials with an animal were undertaken. An interesting series of experiments has been completed, and a report of the results is being published by this Department. In these experiments an attempt was made to determine the relative value both for maintenance and for productive purposes of corn meal as a representative of concentrated feeding stuffs and of clover hay as representing coarse fodders. The studies on the available plant food in soils in cooperation with the Bureau of Chemistry have been continued; also the tobacco investigations in cooperation with the Bureau of Soils, and a study of the losses from manures under different conditions in connection with an experiment in steer feeding in cooperation with the State department of agriculture. The station has also arranged to cooperate with the State department of agriculture and local grape growers in the north-western part of the State in a study of the diseases of fruits with especial reference to the grape. The work in the division of dairy husbandry has been restricted owing to the resignation of the dairyman, but a study of conditions determining the amount of moisture in butter has been made.

The last legislature made an appropriation of \$100,000 toward the erection of an agricultural building for the college and station to cost

not more than \$250,000. The wing provided for in this appropriation is to be devoted to dairying and is now approaching completion. The completed agricultural building will include not only this dairy building but also the respiration calorimeter building which was completed several years ago.

The Pennsylvania Station is very much in need of additional funds to develop its scientific investigations. During the past year the respiration calorimeter, representing an investment approximating \$15,000, was in actual use less than 300 hours, owing to the fact that there were not funds to provide sufficient help to carry on investigations with this apparatus while investigations were going on in other divisions of the station. This is one of the very important lines of investigation in animal husbandry in this country and adequate funds should be provided for its support. There is also need of additional funds for a systematic study of the soils of the State and for investigations to aid in the development of the horticultural and poultry interests. The appropriation already made for the college and station, while it will not directly relieve the station, is very encouraging, owing to the fact that it was secured by the united and persistent demands of the agricultural interests of the State. It is hoped that these interests will continue to demand recognition through increased appropriations for the investigation of problems affecting them.

LINES OF WORK.

The principal lines of work conducted at the Pennsylvania Station during the past year were as follows: Chemistry—cooperation with other departments in the study of foods, feeding stuffs, excreta, fertilizers, and agricultural products, miscellaneous analytical work, study of chemical changes in vinegar and vinegar solids, and of variations in the composition of milk, experiments with tobacco, referee work for the Association of Official Agricultural Chemists of the United States; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture—variety tests of small fruits, experiments with crown gall of fruit trees, growing ginseng; field experiments—rotation experiments with fertilizers on 144 plats, rotation of legumes for soiling purposes, variety tests of farm crops; feeding experiments—investigations in animal nutrition in the respiration calorimeter, feeding steers and correlated chemical studies on the relative losses from the manure of fattening cattle under different conditions of feeding; dairying—building up a herd from common stock, feeding dairy cows, study of the effect of keeping drinking water constantly before cows, effect of variety in the grain ration of cows, experiments to test the value of a home-mixed calf meal as a substitute for milk in rearing calves.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Fees.....	11,220.00
Farm products.....	2,547.08
Miscellaneous.....	181.64
Total.....	28,948.72

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 60-62 on the rearing of calves on milk substitutes, annual report of the director, and an experiment in ginseng culture.

PORTO RICO.

Porto Rico Agricultural Experiment Station, Mayaguez.

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

F. D. Gardner, <i>Special Agent in Charge.</i>	J. Van Leenhoff, jr., <i>Tobacco Expert.</i>
J. W. Van Leenhoff, <i>Coffee Expert.</i>	E. F. Curt, <i>Farm Foreman.</i>
O. W. Barrett, <i>Entomologist, Botanist.</i>	Edw. C. Howe, <i>Clerk, Stenographer.</i>

GENERAL OUTLOOK.

The work of the Porto Rico Station during the past year has consisted largely in the repair of buildings on the new station farm at Mayaguez and the preparation of land and starting of experiments. The farm had not been under close cultivation for a number of years, and had to a considerable extent grown up with weeds, shrubs, etc. It was necessary to repair roads, construct culverts, build fences, clean ditches, and to clear about 15 acres of land before the farm could be brought into condition for experimental purposes. Crops of corn, beans, rice, Kafir corn, and alfalfa were planted, but by reason of insect pests, fungus diseases, and drought, the yields were very meager. Since the harvesting of these crops, land has been laid out in permanent tenth-hectare plats, and a considerable portion of it is now under experiment. Attempts have been made to establish various nurseries, including seedlings of all the varieties of citrus fruits obtainable on the island; a considerable number of tropical plants secured through this Department, including 100 rubber seedlings, 200 tea seedlings, and smaller numbers of figs, pistachios, etc., and many native varieties,

such as mangoes, alligator pears, and the mammee apple. On other parts of the farm an experimental banana plantation and a cacao grove have been started. Arrangements have been made by which plants of economic value are obtained for the station from Jamaica through the Botanic Garden at Kingston and from other portions of the West Indies through the British Commissioner of Agriculture for the West Indies. Through these different sources a considerable number of tropical products have already been collected, among them a large number of varieties of cassava, yams, yautia, and the malanga. Fiber plants are also being tested. Experiments have been continued with vegetables from northern-grown seeds, but as yet with indifferent success.

Experiments with coffee have been carried on during the year and the results of the application of fertilizers have been marked. Bat guano secured from caves on the island has given better results than any of the commercial fertilizers. A large number of coffee seedlings are ready to transplant, and arrangements have been made with a number of planters to set out a half acre of each of these and care for them according to directions prescribed by the station. Many trees will also be planted on the coffee-experiment plats at La Carmelita, where 10 acres have been turned over to the station for experimental purposes.

During the early part of the fiscal year the botanist of the station made a visit to the northeastern part of the island and reported on the boundaries of public lands in the Luquillo district. This region embraces practically all the native forest remaining on the island, and the survey was made to establish the boundaries for a forest reservation of 25,000 acres, which was proclaimed by the President in January, 1903. Later in the year Prof. F. S. Earle, of the New York Botanic Gardens, visited the island as a temporary agent of this Office, to make a study of some of its horticultural possibilities and to make observations upon some of the diseases of economic plants. He has prepared a report on this trip which is given in full on page 454.

Numerous additions, both of bound publications and pamphlets, have been made to the library and exchanges have been effected with a number of publications. A mailing list of about 800 addresses, mostly in Porto Rico, has been prepared. It is planned to continue the soil survey of the island as funds will permit; to continue and extend the coffee experiments, partly in cooperation with representative planters in different parts of the island, and to develop horticultural investigations. There is great demand for information along horticultural lines, and it is exceedingly important that a man well trained in the principles and practices of tropical horticulture be secured by the station. Stock growing is another important industry on the island, and there is considerable demand for investigation in animal industry, for which the

present funds of the station are not adequate. The cordial support which has thus far been accorded to the station by the insular legislature, together with the interest manifested by planters in requesting its publications and in soliciting specific information, is very encouraging and bespeaks for the station a high grade of usefulness. It is confidently believed that the people of Porto Rico will assist the station by adequate appropriations, so that its usefulness may be enlarged from year to year.

LINE OF WORK.

The principal lines of work of the Porto Rico Station during the past year were as follows: Collection and variety tests of tropical, agricultural, and horticultural crops; cultural and fertilizer tests with northern-grown crops to determine their adaptation, time of planting, etc.; investigations of injurious insects, and fungus and bacterial diseases of plants; selection of coffee; rejuvenation of an old coffee plantation; tobacco investigations; soil survey, and distribution of seeds for trial by farmers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$12,000
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PUBLICATIONS.

The fourth report on investigations in Porto Rico, giving a detailed account of operations during the year 1903, has been prepared by the special agent in charge of the Porto Rico Agricultural Experiment Station, and is given on page 419.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, Kingston.

Department of Rhode Island College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Managers: Chas. Dean Kimball (*President*), *Providence*; Jesse V. B. Watson (*Vice-President*), *Wakefield*; C. H. Coggeshall (*Clerk*), *Bristol*; Melville Bull (*Treasurer*), *Newport*; T. G. Mathewson, *East Greenwich*.

STATION STAFF.

H. J. Wheeler, PH. D., <i>Director; Chemist.</i>	G. E. Adams, B. S., <i>Assistant in Field Experiments.</i>
F. W. Card, M. S., <i>Horticulturist.</i>	A. W. Bosworth, B. S., <i>Assistant Chemist.</i>
Cooper Curtice, D. V. S., M. D., <i>Biologist, Poultryman.</i>	A. E. Stene, B. S., <i>Assistant Horticulturist.</i>
B. L. Hartwell, PH. D., <i>Associate Chemist.</i>	Nathaniel Helme, <i>Meteorologist.</i>
J. W. Kellogg, B. S., <i>Assistant Chemist.</i>	S. Aline Nye, <i>Stenographer.</i>
Wilhelm Eissing, <i>Assistant Chemist.</i>	E. M. Chadwick, <i>Stenographer, Librarian.</i>

GENERAL OUTLOOK.

The features of work at the Rhode Island Station do not differ materially from those mentioned in the last report of this Office. The most important line of work continues to be its field experiments in studying the relation of fertilizers and soil conditions to fertility. This has included a study of the replacing power of potash and soda, which has indicated that with certain crops, notably root crops, soda conserves the soil potash. Results have been obtained indicating that ignited alumina phosphate is of little or no value to most crops when used upon a very acid soil. This substance shows a high percentage of reverted phosphoric acid and is said to be used quite extensively in certain ready-mixed commercial fertilizers, upon which account these results are considered particularly valuable. Great success has been had in bringing up the poor land of the station farm with a fertilizer formula, which has been worked out at the station, and the use of lime, and it is asserted that with this treatment any of the poor land of the State which is not too sandy can be brought up so as to produce $3\frac{1}{2}$ tons of hay to the acre. The old worn-out acid soil of the station farm has been renovated by the use of lime and commercial fertilizers in an entirely economical way. The bacteriological flora of limed and unlimed plats is being studied. The horticulturist has begun the selection of red clover with a view to improving it and is testing the effect of tobacco shade cloth on strawberries and a variety of vegetables, also the effect of adding new soil and infusions to supply the bacteria to sterilized soils. In the latter experiments nodules were formed only upon the roots of the soy beans inoculated by applying new soil. In the biological division studies on the blackhead of turkeys have been continued, but without definite results. It is now thought that the disease is transmitted through the egg, although this has not been fully demonstrated. Increased facilities have been furnished this division by the installation of additional inclosures for chicks, a new heating apparatus for the incubator house, and a very complete outfit for the biological laboratory.

Experiments in grass culture in cooperation with farmers give promise of results of great practical value. In cooperation with the Bureau of Chemistry of this Department the station has tested the effect of Paris green containing free arsenic, with results very deleterious to the trees where large amounts of arsenic were present. The agricultural demonstrator employed for the three summer months with a State appropriation was very successful. He went out to the farmers in response to calls, and during the summer months there were more demands for his services than could be met. He frequently visited four or five farms on the same day to give advice and demonstrations in spraying, the treatment of soils, and other practical ques-

tions. He carried the work of the station directly to the farmers and also brought the farmers into closer touch with the college by explaining the opportunities which it afforded for agricultural instruction. The work of this officer was the more important from the fact that the State has no organized farmers' institutes. The vacancy in the office of the president of the college has been filled by the election of Kenyon L. Butterfield, of Michigan.

The Rhode Island Station is unable with its present funds to undertake many of the problems in soil renovation and restoration which are in need of solution. One of the first things which it would undertake if additional funds were provided would be a study of the rôle of potash and soda in certain plants to see what functions the soda accomplishes when it appears to replace a certain amount of potash. The materials are at hand for this purpose, and the theme would undoubtedly make a very profitable one for investigation of the physiological rôle of these constituents.

LINE OF WORK.

The principal lines of work conducted at the Rhode Island Station during the past year were as follows: Chemistry—analytical work in connection with other experimental investigations; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments—fertilizers, rotations *v.* continuous cropping, variety tests, experiments with grasses, comparative tests of insecticides and fungicides; horticulture—rejuvenation of old orchards, manurial experiments with bush fruits, selection and breeding of fruits and vegetables, orchard cover crops, artificial propagation of blackberries, breeding experiments with raspberries and blackberries, study of forest conditions, combating insect pests, experiments in grafting; and poultry experiments—diseases, brooding, incubation, etc.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000. 00
Farm products	1,227. 92
Miscellaneous, including balance from previous year.....	1,251. 50
Total.....	17,479. 42

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 83-92, on improving an orchard, poultry feeding, analyses of commercial fertilizers, goose septicemia, fowl typhoid, the

forests of Rhode Island, commercial fertilizers, further experiments in top-dressing grass land, bush fruits, and the soy bean.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College.*^a

Department of Clemson Agricultural College.

GOVERNING BOARD.

Board of Trustees: R. W. Simpson (*President*), *Pendleton*; P. H. E. Sloan (*Secretary and Treasurer*), *Clemson College*; D. K. Norris, *Catechee*; M. L. Donaldson, *Greenville*; R. E. Bowen, *Briggs*; B. R. Tillman, *Trenton*; J. E. Bradley, *Huders*; W. D. Evans, *Cheraw*; L. A. Sease, *Prosperity*; J. E. Wannamaker, *St. Matthews*; A. T. Smythe, *Charleston*; J. S. Garris, *Spartanburg*; J. E. Tindal, *Silrer*; J. H. Hardin, *Chester*; H. M. Stackhouse (*Secretary of Fertilizer Department*), *Clemson College*.

STATION STAFF.

P. H. Mell, M. E., PH. D., <i>Director</i> .	C. C. McDonnell, B. S., <i>Assistant Chemist</i> .
J. S. Newman, <i>Vice-Director; Agriculturist</i> .	D. H. Henry, B. S., <i>Assistant Chemist</i> .
M. B. Hardin, <i>Chemist</i> .	C. C. Newman, <i>Horticulturist</i> .
H. Metcalf, M. A., PH. D., <i>Botanist, Bacteriologist</i> .	C. E. Chambliss, M. S., <i>Entomologist</i> .
B. F. Robertson, B. S., <i>Assistant Chemist</i> .	G. E. Nesom, B. S., D. V. M., <i>Veterinarian</i> .
F. S. Shiver, PH. G., <i>Assistant Chemist</i> .	B. H. Rawl, B. S., <i>Animal Husbandman</i> .
H. Benton, M. S., <i>Assistant Agriculturist</i> .	J. S. Pickett, <i>Station Foreman</i> .
	J. N. Hook, <i>Secretary</i> .

GENERAL OUTLOOK.

The production of plants for hay and for a succession of pasturage is a leading feature of the work of the South Carolina Station. Orchard grass, redtop, Texas bluegrass, Kentucky bluegrass mixed with white clover (for lawn and pasture), and Bermuda grass have been found worthy of cultivation. Bermuda grass and Texas bluegrass are especially valuable, the former for summer and the latter for fall and spring pasturage. The vetches on Bermuda sod also afford excellent spring pasturage, and hairy vetch sown with oats gave a large yield of excellent hay. Crimson clover and Dwarf Essex rape also gave good results. Experiments with sorghum, teosinte, Kafir corn, cowpeas, and velvet beans for hay resulted in favor of sorghum, teosinte, and cowpeas in the order named. The veterinarian of the station is engaged largely in the work of inspection and continues to make useful observations regarding the practicability of inoculation against Texas fever and on poultry diseases and miscellaneous diseases of stock. He is also making some study of the general questions of breeding stock and providing a succession of forage crops. The station is cooperating with the Bureau of Chemistry of this Department in studying the available plant food in soils and with farmers along the coast in raising Sea-island cotton and truck and forage plants. Station

^aTelegraph office, *Clemson College*; express and freight address, *Calhoun*.

officers took an active part during the past summer in the farmers' institutes, 32 of which were held, with a total attendance of over 8,000. At the round-up institute held at the college the 1st of August nearly 1,500 farmers spent four days in a most enthusiastic meeting. The station is acquiring better facilities for work through the erection of a \$3,000 barn and the purchase of considerable live stock. A new agricultural building for the college and station to cost \$50,000, is in process of construction. The building will be three stories high, with a frontage of 176 feet and a depth of 120 feet.

The South Carolina Station during the past year has been undergoing considerable reorganization, with a view of making a clear differentiation between station and college work. Some progress has been made in this direction by assigning a definite area of land to the station for experimental purposes, erecting a station barn, separating the station herd from the college herd, and relieving the vice-director of the management of the college farm. It is evident, however, that the affairs of the station can not be put on a thoroughly satisfactory basis and its work pushed vigorously until a separate director clothed with proper authority to outline a general plan of work is appointed. Farmers' institutes have been very successful and a useful means of bringing the station officers into touch with the people, but they are now laying upon the Hatch fund a heavy burden, which should be carried by the State with funds especially provided for the purpose. With such funds and with additional resources for developing the horticultural work, the South Carolina Station would be in a position to greatly increase its usefulness in the State.

LINES OF WORK.

The principal lines of work conducted at the South Carolina Station during the past year were as follows: Chemistry—chemistry of Sea-island cotton, plant food in soils, analysis and control of fertilizers; field experiments—domestication of native grasses and other forage crops, tests of crops for economic pork production, rotations, tests of sorghum and Kafir corn for hay; horticulture; plant breeding—cotton, strawberries; feeding experiments—mainly with dairy cows and poultry; veterinary science—diseases of poultry, inoculation for Texas fever; entomology—orchard inspection, methods of destroying insect pests of fruits and vegetables; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000. 00
Farm products	1,687. 63
Total	<u>16,687. 63</u>

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 72-80 and the Annual Report for 1902. The bulletins include two reports on the analysis of commercial fertilizers, one on Texas fever, and the following: Bermuda grass; the standardization of sulphuric acid; the nature, determination, and distribution of the pentosans in the Sea-island cotton; experiments with poultry; cotton culture; and a rotation study.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, Brookings.

Department of South Dakota Agricultural College.

GOVERNING BOARD.

Regents of Education: I. W. Goodner (*President*), *Pierre*; Frederick A. Spafford, *Flandreau*; I. D. Aldrich (*Secretary*), *Bigstone*; M. F. Greeley, *Gary*; A. W. Burt, *Huron*; R. M. Slocum, *Herreid*; R. A. Larson (*Secretary and Accountant*), *Brookings*.

STATION STAFF.

J. W. Wilson, M. S. A., <i>Director; Animal Husbandman.</i>	A. H. Wheaton, <i>Assistant in Dairying.</i>
E. C. Chilcott, M. S., <i>Vice-Director; Agriculturist.</i>	F. E. Hepner, Ph. G., <i>Assistant in Chemistry.</i>
J. H. Shepard, B. S., <i>Chemist.</i>	F. A. Norton, Ph. G., <i>Assistant Chemist.</i>
De Alton Saunders, ^a M. A., <i>Botanist, Entomologist.</i>	R. F. Kerr, M. A., <i>Librarian, Statistician.</i>
W. A. Wheeler, B. A., <i>Botanist.</i>	R. A. Larson, <i>Accountant, Secretary.</i>
E. L. Moore, B. S., D. V. S., <i>Veterinarian.</i>	Sylvester Baltz, <i>Superintendent of Highmore Substation.</i>
N. E. Hansen, M. S., <i>Horticulturist.</i>	H. G. Skinner, B. S. A., <i>Assistant Animal Husbandman.</i>
W. S. Thornber, M. S., <i>Assistant Horticulturist.</i>	T. B. Kelly, <i>Stenographer.</i>
A. B. Holm, B. S., <i>Assistant in Soils.</i>	William West, <i>Farm Foreman.</i>
	Chas. Haralson, <i>Gardener, Florist.</i>

GENERAL OUTLOOK.

The South Dakota Station has continued the investigations already begun and inaugurated work in animal husbandry, especially the feeding of cattle and sheep. A novel feature of the feeding experiments was the use of macaroni wheats, bread wheats, and spelt in comparison with corn. The college with which the station is connected has invested \$3,000 in live stock during the past year. Results of the rotation experiments during the past six years have been published, also a bulletin on macaroni wheat, which is now being studied with special

^a On leave.

reference to its milling qualities. A fine lot of breeding experiments with cereals and legumes was destroyed during the past season by a hailstorm. The veterinarian has recently investigated the fringed tape-worm affecting lambs, and issued a bulletin setting forth the results. Considerable work has been done in cooperation with the farmers of the State in growing grains and grasses introduced by this Department. Tests of these crops were also made at Brookings and at the Highmore Substation in cooperation with the Bureau of Plant Industry of this Department. The station is also cooperating with the Bureau of Plant Industry in making variety tests of vegetables and in improving the wheat industry of the Northwest, with the Bureau of Chemistry on the available plant food in soils, and with this Office in irrigation.

A new chemistry building erected by the college will give the station much greater facilities for chemical work, and a \$12,000 barn now building will afford better facilities for conducting experiments in animal husbandry. A small mill has been installed for testing the milling qualities of varieties of wheat. At the close of the year the president of the college resigned and has since been succeeded by the Rev. James Chalmers, of Elgin, Ill. The funds of this station are not adequate to enable it to meet the needs of the State for investigation of problems arising from the rapid development of the agricultural interests of this region. There is especial need of work in animal husbandry, dairying, and agricultural engineering.

LINE OF WORK.

The principal lines of work conducted at the South Dakota Station during the past year were as follows: Physics and chemistry of soils; field experiments—rotations; plant breeding—selection and adaptation, including native and introduced fruits, cereals, and forage crops; diseases of plants and animals; animal husbandry—feeding experiments; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15, 000. 00
State appropriation.....	1, 200. 00
Miscellaneous.....	954. 16
Total.....	17, 154. 16

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications received from this station during the past fiscal year were Bulletins 75-78, the subjects of which are the treatment of

smuts and rusts, macaroni wheat in South Dakota, a study of Northwestern apples, and a preliminary report on the fringed tapeworm of sheep.

TENNESSEE.

Tennessee Agricultural Experiment Station, Knoxville.

Department of the University of Tennessee.

GOVERNING BOARD.

Board of Trustees—Experiment Station Committee: J. W. Caldwell (*Acting Chairman*), *Knoxville*; T. E. Harwood, *Trenton*; T. F. P. Allison, *Nashville*; O. P. Temple, *Knoxville*; J. B. Killebrew, *Nashville*; Harris Brown, *Gallatin*.

STATION STAFF.

A. M. Soule, B. S. A., <i>Director; Agriculturist.</i>	F. H. Broome, <i>Librarian.</i>
C. A. Keffer, <i>Horticulturist, Forester.</i>	J. R. Fain, B. S., <i>Assistant Agriculturist.</i>
C. A. Mooers, B. S., <i>Chemist.</i>	P. O. Vanatter, <i>Plat Expert.</i>
S. M. Bain, B. A., <i>Botanist.</i>	S. E. Barnes, B. S., M. S. A., <i>Dairyman.</i>
W. M. Fulton, B. A., M. S., <i>Meteorologist.</i>	H. H. Hampton, B. S., <i>Assistant Chemist.</i>
	W. S. Shaw, V. M. D., <i>Veterinarian.</i>
	Ethel Reese, <i>Stenographer.</i>

GENERAL OUTLOOK.

The Tennessee Station continues to devote much attention to problems concerned with the introduction of diversified farming. The growing of forage crops and pasturage is followed by feeding experiments with various animals, the results of which are carefully recorded and tabulated in such a way as to show the actual cost of producing the different animal products. In this way the farmers have been shown the economy of making silage and of feeding the great bulk of their crops instead of selling the raw products. Last year it was announced that silage could be produced for \$1.23 per ton, and this year the station has shown that corn fed in various combinations to hogs has a feeding value of 81 cents per bushel, and skim milk a feeding value of from 26 to 36 cents per 100 pounds, with pork 5 to 7 cents per pound. The station has been working with different crops for silage, and finds that sorghum is nearly as good as corn for this purpose. Soy beans alone were not a success, but mixed with corn in the ratio of 1:2 made good silage.

An attempt is being made to find a legume which can be grown with the corn and which will climb cornstalks in such a way as not to tangle and make difficult harvesting. Work on winter wheats and other cereals has been continued for a number of years with results which indicate that the soil and climate of Tennessee are well adapted to their production and that wheat having excellent milling qualities is produced. Most of this work with forage crops and cereals and also some work with clover seed is being done in cooperation with the Bureau of

Plant Industry of this Department. Closely related to this work is the effort to determine the influence of different methods of soil treatment on crop production and the best means of improving land through grazing. The horticulturist is doing some work with insecticides and with fruits and vegetables under fertilizers. The chemist is devoting considerable attention to fertilizers and soils and has conducted some digestion experiments in connection with the forage and feeding experiments.

The fertilizer inspection has been turned over to the station by the Commissioner of Agriculture and a separate laboratory for the purpose has been fitted up. A two-story feeding barn for cattle has been erected on the university farm. The farm has been increased to an area of 145 acres by the purchase of adjoining land, and as a result the field and feeding experiments have been reorganized and a permanent rotation on the farm established. These improvements were made possible through a special appropriation of \$10,000 for the purpose by the last legislature. This is the first appropriation the station has ever had from the State. The library of the station has been considerably enlarged during the year. The Summer School of the South, conducted under the auspices of the University of Tennessee, had a total enrollment this year (the second of its existence) of 2,150, of whom 1,246 are employed as teachers this year. In the courses given much attention was devoted to rural school subjects, nature study, agriculture, horticulture, and domestic science.

The Tennessee Station is strengthening its staff, systematizing its investigations, and extending its facilities for work. Members of the staff, in addition to their station duties, assist the Commissioner of Agriculture in farmers' institute work. In this way and by means of press bulletins, and a yearbook which is issued annually without expense to the station, its influence is being extended, and it is gradually gaining the support of a large number of farmers. There are many agricultural problems in urgent need of investigation in Tennessee and the resources of the State are sufficiently great to warrant a much more liberal support to both the university and the station.

LINES OF WORK.

The principal lines of work conducted at the Tennessee Station during the past year were as follows: Chemistry—pot and other experiments with soils, digestion experiments, analytical work; fertilizers; field experiments—selection of cereals and legumes, experiments with forage crops for soiling and silage, methods of cultivation, green manuring, tests of meadow grasses, grazing experiments, etc.; horticulture—cultural fertilizer and grafting experiments with orchard and small fruits and vegetables; seeds; weeds; diseases of plants; feeding experiments—beef and dairy cattle and hogs; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products.....	5,582.67
Miscellaneous.....	102.49
Total.....	20,685.16

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1902, containing brief reports from the different departments of the station, and Bulletins Vol. XV, Nos. 3 and 4, on feeding native steers and the relative value of protein in cotton-seed meal, cowpea hay, and wheat bran.

TEXAS.

Texas Agricultural Experiment Station, College Station.

Department of the State Agricultural and Mechanical College of Texas.

GOVERNING BOARD.

Board of Directors: M. Sanson (*President*), *Fort Worth*; F. A. Reichardt, *Houston*; George T. Jester, *Corsicana*; W. J. Clay, *Austin*; P. H. Tobin, *Denison*; K. K. Legett, *Abilene*; A. Haidusek, *Lugrango*; L. D. Amsler, *Hempstead*.

STATION STAFF.

J. A. Craig, B. S. A., <i>Director</i> .	G. S. Fraps, Ph. D., <i>Assistant Chemist</i> .
H. H. Harrington, ^a M. S., <i>Chemist</i> .	F. R. Marshall, <i>Animal Husbandman</i> ,
M. Francis, D. V. M., <i>Veterinarian</i> .	<i>Dairyman</i> .
E. J. Kyle, M. S. A., <i>Horticulturist</i> .	J. W. Carson, B. S. A., <i>Farm Superin-</i>
E. Dwight Sanderson, B. S. A., <i>Consulting</i>	<i>tendent</i> .
<i>Entomologist</i> .	J. K. Robertson, <i>Superintendent of State</i>
E. C. Green, B. S., <i>Assistant Horticulturist</i> .	<i>Station (Beaville)</i> .
F. S. Johnston, B. S., <i>Agriculturist</i> .	W. S. Hotchkiss, <i>Superintendent of State</i>
O. M. Ball, Ph. D., <i>Botanist, Mycologist</i> .	<i>Station (Troupe)</i> .

GENERAL OUTLOOK.

The work of the Texas Station during the past year has been considerably deranged by changes of administration. Nearly the same lines of work have been continued, attention being given to field work in both horticulture and agriculture, studies in veterinary science, feeding experiments, and experiments at the substations. A rather extensive experiment with yearling and two-year-old steers to test the feeding value of rations of cotton-seed meal and hulls; rice bran, polish,

^a On leave.

and hulls, and molasses has been completed. The veterinarian is studying means of rendering cattle immune to Texas fever and of freeing cattle and pastures of ticks. An isolated pasture and quarantine sheds and lots have recently been added to the equipment for such work. The station is giving some attention to means of checking the ravages of the Mexican cotton boll weevil, and is cooperating with the Division of Entomology of this Department in this work, as well as in studies on the San José scale and the Asiatic ladybird. It is also cooperating with the Bureau of Plant Industry in efforts to improve the wheat industry in the Middle West, with the Bureau of Chemistry in studies on the available plant food in soils and on the influence of environment on the sugar content of muskmelons.

The work at the Beeville and Troupe substations is being prosecuted with success, although handicapped somewhat at the latter place by the resignation of the superintendent in charge. The winter-growing of vegetables, especially cabbage and cauliflower, has proven a success. A sewage irrigation garden has been established for growing fall vegetables, especially potatoes, the fall crop of which keep better than the early crop. Experiments with tomatoes and in methods of planting grapes are also in progress, as well as experiments on peaches in cooperation with farmers in Smith County. The substations in Texas have proven very popular, and continual demands are being made for additional institutions of this nature. However, the substation committee of the Farmers' Congress wisely concludes that it is better "to have one new station established with funds sufficient to equip and operate it successfully than to try six weak experiments that would probably reflect no credit on the experiment station movement in the final summing up of results."

The new building for the departments of chemistry and veterinary science has been completed and occupied, and furnishes good facilities for these departments. Work has been started on an \$8,000 dairy barn for the use of the college and the station. At the close of the year the director of the station and dean of the department of agriculture of the college resigned to accept the presidency of the New Hampshire College of Agriculture and directorship of the station. He has been succeeded by John A. Craig, formerly of the Iowa State College of Agriculture, but for several years engaged in editorial work. The agriculturist resigned to go to Louisiana and has been succeeded by F. S. Johnston, formerly of the Indiana School of Agriculture and station. F. R. Marshall, recently of the Iowa College and station, has been elected associate professor of animal husbandry. J. K. Robertson has been made superintendent of the Beeville Station, vice S. A. Henry; and W. S. Hotchkiss, of Illinois, superintendent of the Troupe Station, which for some months past has been under the direction of E. C. Green, of the horticultural department. The chemist has been given a year's leave of absence for travel and study

in Europe. R. L. Bennett, recently director of the Arkansas Station, has been elected superintendent of farmers' institutes.

The Texas Station has undertaken and carried through considerable work of great value to the farmers of the State, and the latter are very appreciative of the fact. They have come to the support of the station in securing a special appropriation for better equipment, and for the establishment of substations to investigate special problems in different localities. The opportunities for investigations of great scientific and practical value are almost unlimited in Texas, and what the station especially needs at the present time is a definite policy with reference to plans for station work, with a clear differentiation between college and station work, and then more settled conditions with regard to the staff of investigators.

LINES OF WORK.

The principal lines of work conducted at the Texas Station during the past year were as follows: Chemistry; meteorology; soils; field experiments—forage crops, variety tests, fertilizer experiments with corn and cotton; horticulture—variety and fertilizer experiments with tomatoes, and experiments with berries and figs; feeding experiments; diseases of animals; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	5,000.00
Miscellaneous	8,737.01
Total	28,737.01

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedule prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 65 and 66 on the tomato and forage crops.

UTAH.

Agricultural Experiment Station, Logan.

Department of the Agricultural College of Utah.

GOVERNING BOARD.

Board of Trustees: W. S. McCormick (*President*), *Salt Lake City*; P. W. Maughan (*Secretary*), *Logan*; Allan M. Fleming (*Treasurer*), *Logan*; Mrs. Emily S. Richards, *Salt Lake City*; John A. McAlister, *Logan*; L. Hansen, *Logan*; Mrs. R. N. Bagley, *Ogden*; George C. Whitmore, *Nephi*; E. R. Owen, *Wellsville*.

STATION STAFF.

J. A. Widtsoe, Ph. D., <i>Director; Chemist.</i>	J. A. Crockett, <i>Assistant Dairyman.</i>
James Dryden, <i>Meteorologist, Poultry Manager.</i>	Robert Stewart, <i>Assistant Chemist.</i>
L. A. Merrill, B. S., <i>Agronomist.</i>	William Jardine, <i>Assistant Agronomist.</i>
W. N. Hutt, B. S. A., <i>Horticulturist.</i>	J. B. Nelson, <i>Farm Foreman.</i>
E. D. Ball, M. S., <i>Biologist.</i>	John Hopkins, <i>Foreman of Poultry Department.</i>
R. W. Clark, B. Sc., <i>Animal Industry.</i>	H. W. Crockett, <i>Foreman of Horticultural Grounds.</i>
W. W. McLaughlin, <i>Irrigation Engineer.</i>	Fred Blatter, <i>Foreman in Animal Industry.</i>
P. A. Yoder, Ph. D., <i>Associate Chemist.</i>	

GENERAL OUTLOOK.

Irrigation continues to be the foundation upon which most of the investigations of the Utah Station are based. The lines of work in progress last year have been continued and new work in some phases of irrigation and in animal husbandry has been added. Feeding experiments with horses, cattle, and sheep have been conducted to study especially the value of sugar factory by-products and the possibilities of the irrigated pasture. The irrigation investigations have been extended to include the study of orchard and garden crops and the effect of irrigation on the soluble elements of the soil. In the laboratory the effect of irrigation water on the nitrogen content of crops is being studied. The protein content of wheat was found to increase and the starch and fat to decrease as the irrigation water was decreased. An attempt is being made to fix these characteristics. During the past three years experiments in dry farming on the station farm have been conducted, and results of such general interest obtained that the last legislature appropriated \$12,500 for extending the work. Six farms of 40 acres each have been selected and are donated for the purpose by the counties in which they are located. Trials will be made with cereals and other field crops. In this connection an effort is being made to change macaroni wheat from a spring to a fall or winter variety by means of selection. Some plants were secured that lived through the winter, and it is thought that a winter variety can be secured. Ten varieties of macaroni wheat have given an average yield of 33 bushels an acre without water on the station farm, and this is, therefore, a very valuable dry-farming crop. Under a system of dry farming, however, it is necessary that the wheat be sown in the fall.

The station is cooperating with this Department as follows: With the Bureau of Soils in the reclamation of a forty-acre tract of alkali land; with the Bureau of Plant Industry in the cultivation of hemp, in the amount of water required by different forage plants, and in the production of sugar-beet seed; with the Bureau of Chemistry on the effect of environment on the composition of sugar beets and on the available plant food in soils. Farmers' institutes have been continued under the auspices of the college, the members of the station staff partici-

pating in the work. Interest in agricultural education is increasing and the grade of instruction in the college being raised. About one-third of the students are now taking agricultural courses. The appointment of an entomologist for the station has made it possible to investigate methods of combating the codling moth, which is the most serious orchard pest in the State. During the year the irrigation engineer and his assistant resigned, and the former was succeeded by W. W. McLaughlin, formerly assistant chemist of the station. R. W. Clark, formerly of Alabama, has been appointed animal husbandman, and William Jardine, assistant agronomist.

The last legislature, in addition to making an appropriation for experiments in dry farming, provided \$6,500 for building purposes, \$2,000 for publications, and appropriations covering the light, water, and fuel bills of the station. The work of the station is attracting a great deal of attention throughout the State and is meeting the approval of the people. The increased funds which the station is receiving from the State is an indication of this. The station work is better systematized than it has ever been before and all of its funds are carefully husbanded, and yet these funds are not sufficient to carry on the investigations already inaugurated, all of which are of primary importance to the agriculture of the State and should be continued. The station should also have additional funds to further develop its work in irrigation, animal husbandry, and horticulture.

LINES OF WORK.

The principal lines of work conducted at the Utah Station during the past year were as follows: Chemistry—soils, feeding stuffs; alkali soil investigations—reclamation of alkali soils; meteorology; field experiments—rotations, testing varieties of cereals, sugar beets and garden vegetables, arid farming; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments—cattle, sheep, horses; dairying; poultry experiments; irrigation—seepage investigations, water requirements of plants and soils.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
Farm crops	3,634.64
Total	18,634.64

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The only publication of this station received during the past fiscal year was Bulletin 77 on horse feeding.

VERMONT.

Vermont Agricultural Experiment Station, *Burlington*.

Department of University of Vermont and State Agricultural College.

GOVERNING BOARD.

Board of Trustees—Board of Control: Matthew Henry Buckham (*President*), *Burlington*; E. J. Ormsbee, *Brandon*; G. S. Fassett, *Enosburg*; Cassius Peck, *Burlington*.

STATION STAFF.

J. L. Hills, D. S., *Director*.
 G. H. Perkins, Ph. D., *Entomologist*.
 L. R. Jones, Ph. B., *Botanist*.
 William Stuart, M. S., *Horticulturist*.
 F. A. Rich, V. S., M. D., *Veterinarian*.
 Cassius Peck, *Farm Superintendent*.

C. H. Jones, B. S., *Chemist*.
 F. M. Hollister, B. S., *Assistant Chemist*.
 W. J. Morse, B. S., *Assistant Botanist*.
 E. S. Gregg, *Dairyman*.
 Mary A. Benson, *Stenographer*.
 E. H. Powell, *Treasurer*.

GENERAL OUTLOOK.

The lines of work at the Vermont Station were not materially altered during the past year, excepting in the horticultural department, where a change in horticulturist resulted in a lessening of pomological studies and increased attention to greenhouse studies and vegetable growing. The results of investigations with maple sap, covering five years, are being prepared for publication. A study of the enzymes of the soft rots has been undertaken by the botanist in cooperation with the New York State Station. The Vermont Station is also cooperating with the Bureau of Chemistry of this Department in studying the available plant food in soils; with the Bureau of Plant Industry in testing medicinal plants, and in experiments to determine the amount and quality of grass and forage-plant seeds offered for sale in Vermont; with the Bureau of Forestry in tree planting experiments; and with this Office in nutrition investigations.

The last season, owing to the failure of crops due to peculiar climatic conditions, was a very discouraging one for the Vermont Station. Poultry work, in connection with the college, has been decided upon, and a poultry house to cost about \$1,000 is now being erected. Some experimental work in this connection is also planned. This station is doing considerable useful work and in some lines has achieved marked success. It deserves more liberal treatment on the part of the State, and greatly needs additional funds for the extension of its work. Recent changes in the State law regarding the inspection of feeding stuffs have lessened the resources of the station.

LINES OF WORK.

The principal lines of work conducted at the Vermont Station during the past year were as follows: Chemistry—composition of potatoes, artichokes, etc., methods of analysis; analysis and control of fertilizers

and feeding stuffs; inspection of creamery glassware; field experiments; botany—grasses and other forage crops, destruction of weeds, etc.; horticulture—propagation, pollenization, and hybridization of plums; diseases of plants; feeding experiments; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	1,090.99
Fees	2,603.22
Total	18,694.21

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 93-99 and the Annual Report for 1902. Four of the bulletins were on commercial fertilizers and commercial feeding stuffs. The others were on apple pomace, a good feed for cows; a poisonous plant, and Vermont grasses and clovers.

VIRGINIA.

Virginia Agricultural Experiment Station, Blacksburg.^a

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

GOVERNING BOARD.

Board of Visitors—Executive Committee: J. T. Brown, *Brierfield*; D. M. Cloyd, *Dublin*; B. R. Selden, *Richmond*; W. R. Robertson, *Plasterco*; J. M. McBryde (*President of the College*), *Blacksburg*.

STATION STAFF.

J. M. McBryde, Ph. D., LL. D., <i>Director</i> .	Meade Ferguson, Ph. D., <i>Assistant Agri-</i>
W. B. Alwood, <i>Vice-Director</i> ; <i>Entomologist</i> .	<i>culturist</i> .
E. A. Smyth, jr., M. A., <i>Biologist</i> .	H. L. Price, M. S., <i>Horticulturist</i> .
D. O. Nourse, B. S., <i>Agriculturist</i> .	J. G. Ferneyhough, D. V. S., <i>Assistant</i>
R. J. Davidson, M. A., <i>Chemist</i> .	<i>Veterinarian</i> .
John Spencer, D. V. S., <i>Veterinarian</i> .	J. H. Gibboney, B. S., <i>Assistant Chemist</i> .
W. A. P. Moncure, M. S., <i>Assistant My-</i>	J. B. McBryde, B. A., C. E., <i>Assistant</i>
<i>cologist</i> .	<i>Chemist</i> .
C. I. Wade, <i>Treasurer</i> .	

GENERAL OUTLOOK.

The leading investigations of the Virginia Station continue to be on the production of vinegar, champagne, and other beverages from cider and fruit juices, a study being made of the yeasts for this purpose.

^a Express and freight address, *Christiansburg Depot*.

The departments of chemistry and horticulture of the station are cooperating in this work and have considerable material ready for publication. There has also been some experimental work in canning fruits and vegetables and on the chemical composition of fruits. The cider investigations are in cooperation with the Bureau of Chemistry of this Department, with which the station is also cooperating in sugar-beet investigations and studies on the available plant food in soils. The entomologist is cooperating with the Division of Entomology of this Department in studies on the San José scale and Asiatic ladybird. The San José scale investigations are also aided by State funds. Diseases of orchard trees have been studied, and a bulletin dealing with pear blight has been published. The application of potash and phosphates to stimulate the trees is recommended. A preliminary study of the crown gall on apple trees has also been completed and published, and one of the conclusions reached is that the disease most likely reaches the nursery through the use of diseased apple seedlings.

The agriculturist has been investigating a number of farm products used as hay substitutes and has found corn stover especially valuable. He has recently started a series of 80 plats for rotation work to study rotations with and without leguminous plants grown with and without fertilizers. He is also continuing some work on the bacteriology of soils. The work of the biologist is largely consulting, but he has made some breeding experiments with Lepidoptera and is preparing a bulletin on the birds of the State, which is to supplement a book published several years ago by another author. A little veterinary work is being done, especially with ticks and other parasites.

Several members of the station staff have attended meetings of farmers during the year and have succeeded in arousing considerable interest in the work of the college and station. Three large laboratories for the chemical department of the station have been fitted up by the college in the new science building. Assistants to the station staff have been added in chemistry, horticulture, mycology, and apiculture. The facilities for work at the Virginia Station have been improved, but there is still need of a more effective organization and additional funds in order that investigations commensurate with the importance of the agricultural interests of the State may be carried on. With the growth of the college the administrative duties of the president have of necessity been greatly increased and it is impracticable for that officer to give such attention to the management of the station as is required to secure its greatest efficiency. A separate director should therefore be secured and given authority to enforce the prompt and regular execution of definite plans of investigation. This officer should also have opportunity to study and promote the agricultural interests of different regions of the State. The inspection work of the station should be clearly differentiated from its investigations and fully supported by State funds.

LINES OF WORK.

The principal lines of work conducted at the Virginia Station during the past year were as follows: Field experiments—study of forage plants, corn and other crops, tillage and manurial experiments, rotations; analysis of foods; horticulture; bacteriology—of milk and soils, critical study of nitrifying and denitrifying bacteria; feeding experiments—feeding steers, study of corn stover, wheat straw, cotton-seed hulls, etc., as substitutes for hay; veterinary science; entomology; cider and vinegar making; and study of ferments.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Farm products	346.32
Miscellaneous	73.85
Total	15,420.17

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1901 and Bulletins 123-132. Bulletins 128-132 comprise a series on orchard studies. The other bulletins are on the use of blackleg vaccine, sheep scab, mange in horses, the stomach worm, and the production of vinegar in cellars. Two special bulletins were received, one on the Virginia State board of crop pest commissioners and the other on inspection of Roanoke County for San José scale.

WASHINGTON.

Washington Agricultural Experiment Station, Pullman.

Department of Washington Agricultural College and School of Science.

GOVERNING BOARD.

Board of Regents: F. J. Barnard, *Seattle*; R. C. McCroskey, *Garfield*; J. P. Sharp (*Vice-President*), *Ellensburg*; U. L. Ettinger (*Treasurer*), *Colfax*; H. D. Crow (*President*), *Spokane*; E. A. Bryan (*Secretary*), *Pullman*.

STATION STAFF.

E. A. Bryan, M. A., LL. D., <i>Director</i> .	George Severance, B. S., <i>Assistant Agriculturist</i> .
E. E. Elliott, M. S., <i>Agriculturist</i> .	W. H. Lawrence, M. A., <i>Assistant Botanist, Entomologist</i> .
R. Kent Beattie, M. A., <i>Botanist, Zoologist</i> .	O. L. Waller, Ph. M., <i>Irrigation Engineer</i> .
N. O. Booth, B. Agr., <i>Horticulturist</i> .	R. W. Thatcher, B. S., <i>Chemist</i> .
Elton Fulmer, M. A., <i>Chemist</i> .	J. S. Cotton, B. A., <i>Assistant in Co-operative Range Experiments</i> .
S. B. Nelson, D. V. M., <i>Veterinarian</i> .	
H. S. Davis, Ph. B., <i>Assistant Zoologist</i> .	

GENERAL OUTLOOK.

During the past fiscal year the Washington Station has continued its former lines of work and developed to a considerable extent investigations in agronomy. A large part of the station farm is now devoted to these investigations, including variety and spraying experiments with wheat, oats, and forage crops in both small plats and fields. Feeding experiments have been made with cattle, sheep, and pigs, a special feature of the work with pigs being an effort to determine the effect of cotton-seed meal in a ration on the quality of lard produced. There are indications that cotton-seed meal produces a marked effect on the lard. The veterinary work is being developed under a special State appropriation and attention is being given to a number of diseases giving trouble in different sections of the State. The veterinarian has also continued studies of plants which are poisonous to stock. The studies on the life history of salmon have been continued. Irrigation investigations in cooperation with this Office have been prosecuted actively in the Yakima Valley. The station is also cooperating with the Bureau of Plant Industry of this Department in cereal and forage crop investigations and in the improvement of northwestern ranges, and with the Bureau of Chemistry in studying the available plant food in soils.

The State has made an appropriation of \$5,000 for the support of farmers' institutes during the next biennium and this work is being developed. It occupies considerable time of the station staff, but is thought to have a good influence in bringing the station into closer touch with the farmers. The work at the Puyallup Substation has been discontinued owing to the fact that the governor vetoed the appropriation of \$12,000 for this enterprise. At the close of the year the botanist and zoologist resigned and has since been succeeded by the assistant botanist, R. K. Beattie. Some progress has been made during the year in organizing the work of the station more definitely and in improving its facilities. It is at present doing a larger amount of useful work than ever before.

LINES OF WORK.

The principal lines of work conducted at the Washington Station during the past year were as follows: Chemistry—methods of analysis, chemical studies of potatoes and oats, and of fertilizers, foods, and dairy products; botany—study of crown gall, black spot, canker, tomato blight, pear blight, grain smuts; bacteriology; soils—subsoiling and soil treatment; field experiments—tests of grasses for pasture, varieties of oats, barley, emmer, spelt, and einkorn, rotations, time of seeding, sugar beets; horticulture—cover crops and fertilizers for orchards, spraying for apple scab, protection from frost, varieties of fruits and vegetables, selection of nursery stock; plant breeding—

cereals, clover, alfalfa, and vetches; diseases of plants; feeding and breeding experiments—cattle, swine, and sheep; veterinary science—control of the squirrel pest, poisonous effect of certain plants on sheep, influence of feeding fungi to horses, glanders, tuberculosis of cattle, heaves, study of influence of animal fat as a conserver of heat; entomology—study of the codling moth in cooperation with other northwestern stations, insects affecting cereals, San José scale and remedies for the same, parasitic diseases of crickets; dairying; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	\$15,000.00
State appropriation	2,339.83
Miscellaneous, including fees and farm products	1,289.35
Total	18,629.18

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 50–53 on the following subjects: A preliminary report on glanders, locating orchards in Washington, planting orchards in Washington, nursery stock for Washington orchards.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, Morgantown.

Department of West Virginia University.

GOVERNING BOARD.

Board of Regents: E. M. Grant, *Morgantown*; C. E. Haworth, *Huntington*; J. W. Hale, *Princeton*; C. M. Babb, *Falls*; J. R. Trotter, *Buckhannon*; D. C. Gallaher, *Charleston*; J. B. Finley, *Parkersburg*; C. D. Oldham, *Moundsville*; W. J. W. Cowden, *Wheeling*.

STATION STAFF.

J. H. Stewart, M. A., <i>Director; Agriculturist.</i>	F. B. Kunst, <i>Assistant Chemist.</i>
B. H. Hite, M. S., <i>Chemist.</i>	Horace Atwood, M. S. Agr., <i>Assistant Agriculturist.</i>
J. L. Sheldon, <i>Bacteriologist.</i>	T. C. Johnson, <i>Assistant Horticulturist.</i>
G. M. John, <i>Assistant Horticulturist.</i>	W. M. Watson, <i>Stenographer.</i>
W. E. Rumsey, B. S. Agr., <i>Assistant Entomologist.</i>	M. A. Stewart, <i>Librarian.</i>
C. D. Howard, B. S., <i>Associate Chemist.</i>	W. J. White, <i>Auditor, Clerk.</i>
	A. R. Whitehill, Ph. D., <i>Treasurer.</i>

GENERAL OUTLOOK.

The work of the West Virginia Station with few exceptions has been a development and continuation of the lines of work outlined in the last report of this Office. The horticultural investigations have been seriously interfered with by frequent changes in the position of horticulturist. The horticulturist appointed less than a year ago has recently accepted a position in charge of extension work at Cornell University, and the work of the department is now in charge of an assistant. The poultry investigations are being continued and broadened, and the plat experiments are being carried on systematically. New apparatus has been devised for the investigations on the effect of pressure on the preservation of food products, and these investigations are being continued. Plans are being made for the inauguration of irrigation experiments in the Ohio Valley. The station is cooperating with the Bureau of Plant Industry of this Department in studying the influence of various combinations of the three important elements of plant food—nitrogen, potash, and phosphoric acid, and with the Office of Public Road Inquiries in building an experimental macadam road.

The resources of the station have been considerably increased through the operation of State inspection laws. The receipts from the sale of products and the fertilizer control during the past year were over \$15,000, and there was an appropriation of \$5,000 for nursery inspection. University funds amounting to \$2,500 were also available for printing. A bacteriologist has recently been appointed to have charge of investigations in vegetable pathology. He has begun his work by making definite inquiries regarding the diseases of fruit most prevalent in the State, and will conduct investigations on some of them. There is an increasing interest in agriculture in the university and among its constituency. The last legislature of the State made an appropriation of \$5,000 for the maintenance of a department of dairying, and the regents of the university have established the department, with W. K. Brainerd, a graduate of the Michigan Agricultural College, in charge. A dairy herd has been secured and two rooms in the basement of one of the university buildings have been fitted up with modern apparatus for home dairying and for a working laboratory in this department. This is an important and wise venture, owing to the fact that milk and dairy products are bringing high prices in the State and that there are so few up-to-date, well-managed dairies.

LINES OF WORK.

The principal lines of work conducted at the West Virginia Station during the past year were as follows: Chemistry—study of insecticides and fungicides, including various crude petroleums, analytical work

with feeding stuffs and waters, study of pressure as a preservative and of the papaw as a source of sugar and vinegar, methods of analysis; analysis and control of fertilizers; inspection of orchards and nurseries; soils—study of fertility by use of rotations, green manures, commercial fertilizers and barnyard manure, study of acid soils, soils of orchard sections, etc.; field experiments—variety tests of cereals and legumes, fertilizer experiments with buckwheat, pastures, and meadows; horticulture—adaptability of mountain-glade lands for truck crops, cranberries and other fruits, study of causes of winterkilling in peach orchards, breeding roses and carnations, forcing experiments with vegetables, study of effect of cross pollination of the apple and other fruits, insecticides and fungicides for controlling San José scale, bitter rot, brown spot, frog eye, and leaf drop; feeding experiments with sheep; poultry experiments—production of meat and eggs, incubation, experiments to improve flavor of meat and eggs of domesticated fowls; and entomology—insects injurious to orchards and orchard products.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Fees.....	13,068.00
Farm products.....	932.00
Miscellaneous.....	2,087.50
Total.....	31,087.50

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 81–83 and a report on the inspection work of the experiment station for the years 1901 and 1902. The bulletins were on the following subjects: Vegetable gardening in the mountain glades, peach growing in West Virginia, and poultry experiments.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison*.

Department of the University of Wisconsin.

GOVERNING BOARD.

Board of Regents: George F. Merrill (*President*), *Ashland*; President of University, *Madison*; State Superintendent of Instruction (*ex officio*), *Madison*; James C. Kerwin (*Vice President*), *Neshanic*; E. F. Riley (*Secretary*), *Madison*; William F. Vilas, *Madison*; Almah J. Frisby, *Milwaukee*; H. C. Taylor, *Oxfordville*; D. T. Parker, *Fennimore*; James M. Pereles, *Milwaukee*; Arthur J. Puls, *Milwaukee*; M. C. Mead, *Plymouth*; Edward Evans, *La Crosse*; E. A. Edmonds, *Oconto*; August J. Myrland, *Grantsburg*.

STATION STAFF.

W. A. Henry, B. Agr., *Director*.

S. M. Babcock, Ph. D., *Assistant Director*;
Chief Chemist.

A. R. Whitson, B. S., *Agricultural Physi-
cist*.

E. P. Sandsten, M. S., *Horticulturist*.

Frederic Cranfield, *Assistant Horticul-
turist*.

E. H. Farrington, M. S., *Dairy Husband-
man*.

U. C. Baer, *Assistant Dairy Husbandman*.

G. C. Humphrey, B. S., *Animal Husband-
man*.

H. L. Russell, Ph. D., *Bacteriologist*.

E. G. Hastings, *Assistant Bacteriologist*.

R. A. Moore, *Agronomist*.

F. W. Woll, M. S., *Chemist*.

J. C. Brown, M. S., *Assistant Chemist*.

F. J. Wells, *Assistant Agricultural Physicist*.

G. A. Olson, B. S., *Assistant Chemist*.

L. H. Adams, *Farm Superintendent*.

Ida Herfurth, *Clerk*.

A. L. Stone, *Assistant Agronomist*.

W. B. Richards, *Assistant Animal Hus-
bandman*.

Sophie M. Briggs, *Librarian*.

GENERAL OUTLOOK.

The work at the Wisconsin Station is progressing along substantially the same lines as heretofore. Much valuable material has been prepared and published during the year regarding feeding experiments and other investigations with cows, sheep, and swine; investigations in curing cheese at low temperatures, and on other problems in dairying, and in soils. The last legislature appropriated \$25,000 for furnishing and equipping the new agricultural building, \$15,000 for a new agricultural engineering building, \$10,000 for the purchase of improved live stock, \$10,000 for the purchase of additional farm lands, \$1,500 annually for two years for tobacco investigations, and \$2,500 annually for two years for cranberry investigations. The tobacco investigations have been started at Janesville Center and Rio, where experiments have been conducted in growing Sumatra tobacco and Habana seed-leaf tobacco under shade. The cranberry investigations have been going on for a number of years under the auspices of the Wisconsin State Cranberry Growers' Association. The material in the hands of this association has been turned over to the station, and a company engaged in growing cranberries, near Cranmoor, has leased the station 7 acres of land for a cranberry experiment station. On this area a reservoir has been constructed, and adjacent to this, situated so as to be easily flooded, are plats designed for variety tests, tests with fertilizers, tests in sanding, in controlling water, etc. A small house has been erected nearby for the accommodation of employees. The station has continued to cooperate with the Bureau of Animal Industry of this Department, in investigations on ripening cheese at low temperatures; with the Bureau of Chemistry, in sugar-beet investigations and studies of plant food in soils; with the Bureau of Plant Industry, in investigations of cereals, forage, and other crops, and on the influence of origin of red-clover seed on yield of crop, and with this Office, in irrigation investigations.

The new agricultural building erected at a total cost for construction and furnishing of \$175,000, is now occupied. In this building provision is made for the administrative offices of the college and station, as well as the departments of agronomy, animal husbandry, bacteriology, and chemistry, and the office of the superintendent of farmers' institutes. The structure has a frontage of 200 feet and a depth of 64 feet, and is three stories in height above a basement. In the rear is an addition in the form of an octagon, two stories in height and 66 feet across, designed for an auditorium and library. The building is constructed of buff pressed brick, terra cotta, and Indiana buff Bedford limestone. It has a roof of red tile and all outside metal work, including cornice, is of copper. It is of slow-burning construction throughout. Plans are also being made for the agricultural engineering building mentioned above, and a department of agricultural engineering has been established, with G. N. Knapp, formerly of the United States Geological Survey, in charge. Charles R. Van Hise, professor of geology in the university, has been elected president of the university. The professor of animal husbandry in the college of agriculture and animal husbandman of the station has recently accepted a similar position in Colorado, and is succeeded by George C. Humphrey, formerly of Michigan.

The Wisconsin Station continues to be very active in its work and is doing not only a large amount of thoroughly scientific investigating, but also much work intended to carry the results of these investigations directly to the farmer. The Wisconsin Agricultural Experimental Association is becoming a very efficient agency through which to conduct demonstration work and cooperative investigations. The last legislature recognized the importance of this association to the agriculture of the State by granting it an appropriation of \$1,000 for expenses and directing the State printer to print 5,000 copies of its annual report. Farmers' institutes conducted under the auspices of the university are also exerting a powerful influence for the improvement of agricultural practice. With its improved facilities and effective organization the station could profitably use a larger maintenance fund for the extension of its experimental operations.

LINE OF WORK.

The principal lines of work conducted at the Wisconsin Station during the past year were as follows: Chemistry—studies of silage and of the effect of nitrates on the protein content of corn, oats, rape, and cowpeas; bacteriology—studies of silage, diseases of animals, etc.; soils—pot and field experiments with muck; field experiments—cereals and forage crops; horticulture—studies of seedling plums, effects of pinching back raspberries, etc.; feeding experiments—horses, cattle,

sheep, and swine; dairying—cheese ripening at low temperatures, experiments with skim milk, condensed milk, and cream; drainage; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
State appropriation.....	15,000.00
Fees.....	1,800.00
Total.....	31,800.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 92-99 and the Annual Report for 1902. Bulletins 92, 97, and 99 contain the reports on licensed commercial fertilizers and concentrated feeding stuffs. The other bulletins were on the development and distribution of nitrates in cultivated soils, curing of Cheddar cheese with especial reference to cold curing, some observations on sheep breeding from the experiment station flock records, investigations of methods of milking, and the prevention of oat smut and potato scab. The Annual Report contains in addition to data of an administrative nature reports on the following subjects: Experiments on black marsh soils; analysis of licensed fertilizers and feeding stuffs; relation of crop production to amount of water available and methods of cultivation; influence of the soil on the protein content of crops; experiments with grain and forage crops; sugar-beet experiments; fourth annual report on experiments in pinching raspberry shoots; the influence of formaldehyde on the germination of oats; the effect of depth of planting on the germination of clover seed; three types of market sheep; comparative value and effect upon the lambs of feeding various grain rations to pregnant ewes; some observations on sheep breeding from the experiment station flock records; whole corn compared with corn meal for fattening pigs; results of an experiment to determine the comparative effect upon the growth, development, and character of the carcass of pigs fed upon rations of ground peas and corn meal; the results of a feeding trial comparing razorback with crossbred razorback and improved breeds of hogs; licensed commercial feeding stuffs for 1902-3; investigation of methods of milking; official tests of dairy cows, 1901-2; observations on the use of acid tests for milk and cream; a modified cream test bottle; the composition of frozen milk; pasteurized cream butter; difficulties in the way

of drawing conclusions from experiments in butter making when based on one judge's scores; influence of cold curing on the quality of Cheddar cheese; influence of temperatures approximating 60° F. on the development of flavor in cold-cured cheese; influence of varying quantities of rennet on cold-cured cheese; conditions affecting the development of white specks in cold-cured cheese; road construction.

WYOMING.

Wyoming Agricultural Experiment Station, *Laramie*.

Department of the University of Wyoming.

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Board of Trustees: Otto Gramm (*President*), *Laramie*; T. F. Burke (*Vice-President*), *Cheyenne*; Grace R. Hebard (*Secretary*), *Cheyenne*; J. C. Davis (*Treasurer*), *Rawlins*; A. C. Jones, *Laramie*; W. G. Aber, *Wolf*; Bessie A. Stone, *Franston*; H. L. Stevens, *Laramie*; Harriet Knight, *Cheyenne*; A. J. Mokler, *Casper*; T. T. Tynan (*State Superintendent of Public Instruction*), *Cheyenne*; C. W. Lewis (*President of the University*), *Laramie*.

STATION STAFF.

B. C. Buffum, M. S., <i>Director; Agriculturist.</i>	E. E. Nelson, M. A., <i>Assistant Horticulturist, Agrostologist.</i>
Aven Nelson, M. S., M. A., <i>Botanist.</i>	Grace R. Hebard, Ph. D., <i>Secretary.</i>
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B. P. Fleming, B. S., <i>Assistant in Irrigation.</i>	N. Albin Nelson, <i>Assistant Meteorologist.</i>
	L. Case, <i>Stenographer.</i>

GENERAL OUTLOOK.

The Wyoming Station continues to give prominence to irrigation investigations and range problems, and has published during the year a report on measurement of water. Investigations on the duty of water have been continued. The results of a survey of native shrubs and studies of native birds, food adulterants, and troubles with shade trees have been published. The recently inaugurated experiments include tests of the feeding value of field peas and home-grown cereals at high altitudes, breeding experiments with horses and cattle, digestion, and poultry experiments. The station is cooperating with farmers in growing grasses and forage crops, and efforts are being made to get stockmen to undertake feeding experiments. Cooperation with this Department has included sugar-beet investigations and studies of the available plant food in soils with the Bureau of Chemistry, and irrigation investigations with this Office.

One result of the food work of the station was the passage of a pure-food law by the last legislature. The law designated the chemist of the station as State chemist, and carries an appropriation of \$1,000 per year to provide an assistant to do the analytical work. An appropriation of \$15,000 for an armory and gymnasium for the university was also made. The State Board of Charities has turned over to the

university and station the penitentiary buildings and farm in Laramie recently vacated. There is thus added to the college and station equipment buildings which cost originally about \$100,000 and a farm of 320 acres situated on the Laramie River, where an abundance of good water is at hand. The final purchase of the old experiment station farm, consisting of 120 acres, has been authorized. The professor of geology and mining engineering in the university and geologist of the station died July 28, 1903. The president of the university resigned, to take effect September 1 of the present year, and has been succeeded by Charles W. Lewis, formerly president of Moores Hill College in Indiana.

The Wyoming Station is undertaking the solution of problems of leading importance to the agricultural interests of the State, namely, those concerned with the development of new areas under irrigation and the improvement of ranges. Its facilities for work have been greatly increased recently by the acquirement of new buildings and additional farm lands, thus paving the way for extending the work in animal husbandry, which is one of the leading agricultural resources of the State. The station could profitably use additional funds in this work and also in the inauguration of more thorough investigations in several other lines. With the limited funds now at the disposal of this station its work should be concentrated in a few lines which have a direct bearing on the leading agricultural problems of the State, and every effort should be made to formulate definite plans of work and secure their effective execution.

LINES OF WORK.

The principal lines of work conducted at the Wyoming Station during the past year were as follows: Geology; botany—botanical survey, experiments with grasses, legumes, saltbushes, and other forage crops; range improvement; meteorology; waters; soils—rotations, continuous cropping, cultural experiments, renovators, study of soil characteristics; fertilizers; field experiments—variety tests and cultural experiments with cereals, forage crops, and garden vegetables; analysis of foods; feeding experiments—horses, milch cows, pigs, poultry, range sheep and lambs; entomology; and irrigation—measurement of water on station farm, plat experiments, effects of irrigation on alkali.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation.....	\$15,000.00
Individuals.....	120.00
Fees.....	220.39
Farm products.....	385.10
Total.....	15,725.49

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1902 and Bulletins 50-58, on native vines in Wyoming homes, sheep feeding on the range, experiments in evaporation, the measurement of water for irrigation, shrubs, birds, food adulterations, shade-tree suggestions, and growing and preparing agricultural crops for exhibition.

PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ISSUED DURING 1903.*

EXPERIMENT STATION RECORD.

Title.	Editor.
Experiment Station Record, Vol. XIV (1902-3), Nos. 5-12.....	E. W. Allen.
Experiment Station Record, Vol. XV (1903-4), Nos. 1-4.....	Do.

ANNUAL REPORTS.

Title.	Author.
Report of the Director of the Office of Experiment Stations for 1902	A. C. True.
Report of the Director of the Office of Experiment Stations for 1903	Do.
Annual Report of the Office of Experiment Stations for the Year ended June 30, 1902.	Do.

ARTICLES IN THE YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

Some Engineering Features of Drainage (Yearbook, 1902, pp. 231-244).....	C. G. Elliott.
The Cost of Food as Related to its Nutritive Value (Yearbook, 1902, pp. 387-406).	R. D. Milner.
Progress in Secondary Education in Agriculture (Yearbook, 1902, pp. 481-500).	A. C. True.
Some Practical Results of Experiment Station Work (Yearbook, 1902, pp. 589-606).	W. H. Beal.

BULLETINS.

Number.	Title.	Author.
Bulletin 121	Experiments on the Metabolism of Nitrogen, Sulphur, and Phosphorus in the Human Organism.	H. C. Sherman.
Bulletin 122	Organization Lists of the Agricultural Colleges and Experiment Stations in the United States.	D. J. Crosby and M. T. Spethmann.
Bulletin 123	Proceedings of the Sixteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Atlanta, Ga., October 7-9, 1902.	A. C. True, W. H. Beal, and H. C. White.
Bulletin 124	Report of Irrigation Investigations in Utah.....	E. Mead et al.
Bulletin 125	A Digest of Recent Experiments on Horse Feeding.....	C. F. Langworthy.
Bulletin 126	Studies on the Digestibility and Nutritive Value of Bread at the University of Minnesota in 1900-1902.	H. Snyder.
Bulletin 127	Instruction in Agronomy at Some Agricultural Colleges..	A. C. True and D. J. Crosby.

* A list of publications issued by the Office from its organization to 1899 was published in Bulletin No. 80, p. 508, of the Office of Experiment Stations, and of those issued during 1902 in Annual Report of the Office of Experiment Stations, 1902, p. 122.

Publications of the Office of Experiment Stations issued during 1903—Continued.

BULLETINS—Continued.

Number.	Title.	Author.
Bulletin 128	Statistics of the Land-Grant Colleges and Agricultural Experiment Stations in the United States for the Year ended June 30, 1902.	M. T. Spethmann.
Bulletin 129	Dietary Studies in Boston and Springfield, Mass., Philadelphia, Pa., and Chicago, Ill.	R. D. Milner et al.
Bulletin 130	Egyptian Irrigation: A Study of Irrigation Methods and Administration in Egypt.	C. T. Johnston.
Bulletin 131	Plans of Structures in Use on Irrigation Canals in the United States.	E. Mead.
Bulletin 132	Further Investigations Among Fruitarians at the California Agricultural Experiment Station, 1901-2.	M. E. Jaffa.
Bulletin 133	Report of Irrigation Investigations for 1902.	E. Mead et al.
Bulletin 134	Storage of Water on Cache la Poudre and Big Thompson Rivers.	C. E. Tait.
Bulletin 135	Legislation Relating to Farmers' Institutes in the United States and the Province of Ontario, Canada.	J. Hamilton.
Bulletin 136	Experiments on the Metabolism of Matter and Energy in the Human Body, 1900-1902.	W. O. Atwater, F. G. Benedict, et al.
Bulletin 137	Organization Lists of the Agricultural Colleges and Experiment Stations in the United States.	D. J. Crosby and M. T. Spethmann.
Bulletin 138	Proceedings of the Eighth Annual Meeting of the American Association of Farmers' Institute Workers, 1903.	W. H. Reel and G. C. Creelman, editors.
Bulletin 139	Special and Short Courses in Agricultural Colleges.	D. J. Crosby.
Bulletin 140	Acquirement of Water Rights in the Arkansas Valley in Colorado.	J. S. Greene.

FARMERS' BULLETINS.^a

Bulletin 162	Experiment Station Work, XXI	W. H. Beal, editor.
Bulletin 169	Experiment Station Work, XXII	Do.
Bulletin 170	Principles of Horse Feeding	C. F. Langworthy.
Bulletin 182	Poultry as Food	H. W. Atwater.

CIRCULARS.

Circular 50	Preliminary Plans and Estimates for Drainage of Fresno District, California.	C. G. Elliott.
Circular 51	List of State Directors of Farmers' Institutes and Farmers' Institute Lecturers of the United States.	J. Hamilton.
Circular 52	A Few Good Books and Bulletins on Nature Study, School Gardening, and Elementary Agriculture for Common Schools.	D. J. Crosby.
Circular 53	Report of the Committee on Rural Engineering of the Association of American Agricultural Colleges and Experiment Stations.	W. E. Stone et al.
Circular 54	Report of Committee on Indexing Agricultural Literature.	A. C. True et al.
Circular 55	The Relation of the Natural Sciences to Agriculture in a Four-Year College Course.	Do.
Circular 56	Constitution of the Association of American Agricultural Colleges and Experiment Stations, as amended at the Seventeenth Annual Convention of the Association, Washington, D. C., November 17-19, 1903.	

^aThese are published as part of a general series issued by the United States Department of Agriculture.

STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS DURING 1903.

ALABAMA STATION.

Publication.	Title.	Author.
1902.		
Bulletin 121	Dairy Herd Record and Creamery Notes	R. W. Clark.
Annual Report	Fifteenth Annual Report, 1902.	
1903.		
Bulletin 122	Grazing and Feeding Experiments with Pigs	J. F. Duggar.
Bulletin 123	Vetch, Cowpea, and Soy Bean Hay as Substitutes for Wheat Bran	
Bulletin 124	The Horticultural Law. Notes on some of the Insects and Fungus Diseases Affecting Horticultural Crops.	R. S. Mackintosh.
Bulletin 125	Some Diseases of Cattle	C. A. Cary and F. G. Matthews.
Bulletin 126	A Leaf-Curl Disease of Oaks	
		E. M. Wilcox.

ALABAMA CANEBRAKE STATION.

1903.		
Bulletin 19	Tests with Oats and Wheat at Uniontown in 1903	J. F. Duggar and J. M. Richeson.

ALASKA STATIONS.

1902.		
Annual Report	Annual Report, 1902	C. C. Georgeson.

ARIZONA STATION.

1902.		
Index, Vol. III	Index to Bulletins 33-40, Annual Reports, 1900-1901.	
Annual Report	Thirteenth Annual Report, 1902	
1903.		
Bulletin 46	The Underground Waters of Arizona	W. W. Skinner.

ARKANSAS STATION.

1903.		
Bulletin 76	Pig Feeding Experiments with Cotton-seed Meal	R. R. Dinwiddie. C. L. Newman. J. F. Moore.
Bulletin 77	Cowpea Experiments	
Bulletin 78	Experiments with Edible Oils	

CALIFORNIA STATION.

1902.		
Seed Bulletin	Distribution of Seeds and Plants	E. J. Wickson.
Bulletin 145	The Red Spider of Citrus Trees	C. W. Woodworth.
Bulletin 146	New Methods of Grafting and Budding Vines	E. H. Twight.
1903.		
Circular 1	Texas Fever	A. R. Ward.
Circular	The New Fertilizer Law	E. W. Hilgard.
Circular 2	Blackleg	A. R. Ward.

A list of the publications issued by the stations from 1875 to 1899 was published in Bulletin 80, p. 512 of the Office of Experiment Stations and lists of those issued in subsequent years in the following Bulletins of the Office of Experiment Stations: 1900, Bulletin 88, p. 89; 1901, Bulletin 111, p. 74; and 1902, Annual Report of the Office of Experiment Stations, 1902, p. 194.

Station publications received by the Office of Experiment Stations during 1903—Continued.

CALIFORNIA STATION—Continued.

Publication.	Title.	Author.
1903.		
Circular 3.....	Hog Cholera	A. R. Ward.
Circular 4.....	Anthrax	Do.
Circular 5.....	Contagious Abortion in Cows.....	J. Law.
Circular 6.....	Methods of Physical and Chemical Soil Analysis.....	E. W. Hilgard.
Circular 7.....	Remedies for Insects.....	C. W. Woodworth.
Circular 8.....	Laboratory Method for Ordinary Chemical Examination of Waters for Irrigation and Domestic Purposes.....	
Bulletin 147.....	Culture Work at the Substations, 1899-1901	C. H. Shinn.
Bulletin 148.....	Resistant Vines and their Hybrids.....	E. H. Twight.
Bulletin 149.....	The California Sugar Industry.....	G. W. Shaw.
Bulletin 150.....	The Value of Oak Leaves for Forage.....	W. W. Mackie.
Bulletin 151.....	Arsenical Insecticides	G. E. Colby.
Bulletin 152.....	Fumigation Dosage.....	C. W. Woodworth.
Bulletin 153.....	Spraying with Distillates	W. H. Volek.
Bulletin 154.....	Sulphur Sprays for Red Spiders.....	Do.

COLORADO STATION.

1902.		
Annual Report	Fifteenth Annual Report, 1902.....	
1903.		
Bulletin 77.....	Unirrigated Lands of Eastern Colorado.....	J. E. Payne.
Bulletin 78.....	The Tomato Industry of the Arkansas Valley	H. H. Griffin.
Bulletin 79.....	Treatment of Stinking Smut in Wheat	J. Reed.
Bulletin 80.....	Laying Down of Peach Trees	W. Paddock.
Bulletin 81.....	Onion Growing in the Cache la Poudre Valley	Do.
Bulletin 82.....	Colorado Irrigation Waters and their Changes.....	W. P. Headden.
Bulletin 83.....	Irrigation Waters and their Effects.....	Do.
Bulletin 84.....	An Apricot Blight	W. Paddock.

CONNECTICUT STATE STATION.

1902.		
Annual Report....	Annual Report, 1902—Parts II, III, and IV.....	
1903.		
Bulletin 141	Commercial Feeding Stuffs in the Connecticut Market...	A. L. Winton et al.
Bulletin 142	Spray Calendar	W. E. Britton and G. P. Clinton.
Bulletin 143	Two Common Scale Insects of the Orchard.....	W. E. Britton.
Bulletin 144	Fighting the San José Scale Insect in 1903.....	W. E. Britton and B. H. Walden.
Annual Report	Annual Report, 1903—Part I	

CONNECTICUT STORRS STATION.

1901.		
Annual Report....	Fourteenth Annual Report, 1901.....	
1903.		
Bulletin 25	The Covered Pail a Factor in Sanitary Milk Production...	W. A. Stocking, jr.
Bulletin 26	The Relation of Temperature to the Keeping Property of Milk.	H. W. Conn.
Bulletin 27	Poultry as Food.....	R. D. Milner.

Station publications received by the Office of Experiment Stations during 1903—Continued.

DELAWARE STATION.

Publication.	Title.	Author.
1902.		
Annual Report	Fourteenth Annual Report, 1902.....	
1903.		
Bulletin 58	The San José Scale.....	E. D. Sanderson.
Bulletin 59	The Codling Moth	Do.
Bulletin 60	Cover Crops as Green Manure.....	C. L. Penny.
Bulletin 61	Orchard Cover Crops in Delaware.....	C. P. Close.

FLORIDA STATION.

1902.		
Bulletin 64	Texas Cattle Fever and Salt-Sick	C. F. Dawson.
Bulletin 65	The Kumquats	H. H. Hume.
1903.		
Bulletin 66	The Mandarin Orange Group	Do.
Bulletin 67	White Fly	H. A. Gossard.
Bulletin 68	Pineapple Culture	H. K. Miller and H. H. Hume.

GEORGIA STATION.

1902.		
Bulletin 58	Corn Culture.....	R. J. Redding.
Bulletin 59	Cotton Culture.....	Do.
Annual Report	Fifteenth Annual Report, 1902	
1903.		
Bulletin 60	Common Ailments of Breeding Cattle.....	C. L. Willoughby.

HAWAII STATION.

1902.		
Bulletin 2	The Root Rot of Taro	T. F. Sedgwick.
Annual Report	Annual Report, 1902	J. G. Smith.
1903.		
Bulletin 3	Insecticides for Use in Hawaii.....	D. L. Van Dine.
Bulletin 4	The Cultivation of Sisal in Hawaii	F. E. Conter.

IDAHO STATION.

1902.		
Bulletin 31	Tomato Culture.	F. A. Huntley.
Annual Report	Annual Report, 1902	
1903.		
Bulletin 35.....	Meteorological Records. Soil Temperatures	J. E. Bonebright.
Bulletin 36.....	The Codling Moth	J. M. Aldrich.
Bulletin 37.....	Some Conditions of Stock Poisoning in Idaho.....	H. B. Slade.
Bulletin 38.....	Grasses and Forage Plants in Idaho	L. F. Henderson.

Station publications received by the Office of Experiment Stations during 1903—Continued.

ILLINOIS STATION.

Publication.	Title.	Author.
1902.		
Bulletin 82.....	Methods of Corn Breeding.....	C. G. Hopkins.
Report.....	Special Report of the Agricultural Experiment Station ..	
Circular 61.....	Supplement to Bulletin 73.....	H. W. Mumford.
Annual Report....	Fifteenth Annual Report, 1902.....	
1903.		
Bulletin 83.....	Feeds Supplementary to Corn for Fattening Steers.....	Do.
Bulletin 84.....	Dairy Conditions and Suggestions for their Improvement.	W. J. Fraser.
Bulletin 85.....	Records of Individual Cows on Dairy Farms.....	A. J. Glover.
Bulletin 86.....	Climate of Illinois.....	J. G. Mosier.
Bulletin 87.....	The Structure of the Corn Kernel and the Composition of Its Different Parts.	C. G. Hopkins, L. H. Smith, and E. M. East.
Bulletin 88.....	Soil Treatment for Wheat in Rotations, with special ref- erence to Southern Illinois Soils.	C. G. Hopkins.
Circular 62.....	Sugar-Beet Investigations in Illinois.....	C. G. Hopkins and L. H. Smith.
Circular 63.....	Dairy Investigations.....	W. J. Fraser.
Circular 64.....	Investigation of Illinois Soils.....	C. G. Hopkins.
Circular 65.....	Live-Stock Investigations.....	H. W. Mumford.
Circular 66.....	Corn Experiments in Illinois.....	C. G. Hopkins, L. H. Smith, and A. D. Shamel.
Circular 67.....	Fruit and Orchard Investigations.....	
Circular 68.....	Methods of Maintaining the Productive Capacity of Illi- nois Soils.	C. G. Hopkins.
Circular 69.....	The Cowpea and Soy Bean in Illinois.....	D. S. Dalbey.
Circular 70.....	Infected Alfalfa Soil.....	C. G. Hopkins.
Circular 71.....	Roasting of Beef.....	Isabel Beyler and Eliz- abeth C. Sprague.
Circular 72.....	Present Status of Soil Investigations.....	C. G. Hopkins.
Annual Report....	Sixteenth Annual Report, 1903.....	

INDIANA STATION.

1902.		
Annual Report....	Fifteenth Annual Report, 1902.....	
1903.		
Bulletin 94.....	Diseases of Sheep.....	R. A. Craig and A. W. Bitting.
Bulletin 95.....	Unproductive Black Soil.....	H. A. Huston.
Bulletin 96.....	Suggestions Concerning the Care of Milk and Butter- making on the Farm.	H. E. Van Norman.

IOWA STATION.

1902.		
Bulletin 67.....	The Chemical Composition of Food Preservatives.....	J. B. Weems and I. J. Mead.
	Solutions for Testing Cream and Milk.....	J. B. Weems and C. E. Gray.
1903.		
Bulletin 68.....	Selecting and Preparing Seed Corn.....	P. G. Holden et al.
Bulletin 69.....	The Chicken Mite.....	J. J. Repp.
Bulletin 70.....	Some Weeds of Iowa.....	L. H. Pammel.
Bulletin 71.....	The Keeping Quality of Butter.....	G. L. McKay and C. Larsen.
Bulletin 72.....	Cold Storage of Apples.....	H. C. Price.
Bulletin 73.....	Cherries and Cherry Growing in Iowa.....	H. C. Price and E. E. Little.

Station publications received by the Office of Experiment Stations during 1903—Continued

KANSAS STATION.

Publication.	Title.	Author.
1902.		
Bulletin 115	The Exact Calculation of Balanced Rations.....	J. T. Willard.
1903.		
Bulletin 116	Destroying Prairie Dogs and Pocket Gophers.....	D. E. Lantz.
Bulletin 117	Bacteria of the Soil	N. S. Mayo and A. T. Kinsley.
Bulletin 118	Flesh and Fat in Beef	D. H. Otis.
Bulletin 119	Press Bulletins Nos. 71-124.....	
Annual Report	Sixteenth Annual Report, 1903.....	

KENTUCKY STATION.

1902.		
Bulletin 103	Hessian Fly Experiments.....	H. Garman.
Bulletin 104	Commercial Fertilizers	M. A. Scovell and H. E. Curtis.
1903.		
Bulletin 105	The Broom Rapeseed.....	H. Garman.
Bulletin 106	Feeding Dairy Cows	D. W. May.
Bulletin 107	Seventeen-Year Locusts in Kentucky	H. Garman.
Bulletin 108	Some Results in Steer Feeding.....	D. W. May.
Bulletin 109	Commercial Fertilizers	M. A. Scovell and H. E. Curtis.

LOUISIANA STATIONS.

1902.		
Bulletin 72	Forage Crops, Grasses, Alfalfa, Clovers, etc.....	W. R. Dodson.
Bulletin 73	Analyses of Commercial Fertilizers and Paris Green	C. H. O'Rourke.
Annual Report	Fifteenth Annual Report, 1902.....	
1903.		
Bulletin 74	Sheep	W. H. Dalrymple.
Bulletin 75	Preservation of Cane Sirup	W. R. Dodson.
	The Enzymes of the Sugar Cane.....	C. A. Browne, jr.
	Special Device for Keeping Sirup in a Sterile Condition.	W. R. Dodson.
	Relation of Bacteria to the Inversion of Crystallized Sugar.	
Circular 1.....	The Mexican Cotton-boll Weevil	W. C. Stubbs et al.

MAINE STATION.

1902.		
Bulletin 87	Potato Insecticides and Fungicides in 1902. Out Smut and Its Prevention.	C. D. Woods.
Bulletin 88	Finances, Meteorology, Index	
Annual Report	Eighteenth Annual Report, 1902	
1903.		
Bulletin 89	Experiments in Orchard Culture	W. M. Munson.
Bulletin 90	Fertilizer Inspection.....	C. D. Woods and J. M. Bartlett.
Bulletin 91	The Chinch Bug in Maine	H. W. Britcher.
Bulletin 92	Feeding Stuff Inspection	C. D. Woods and J. M. Bartlett.
Bulletin 93	Poultry Experiments in 1902.....	G. M. Gowell.
Bulletin 94	Fertilizer Inspection.....	C. D. Woods and J. M. Bartlett.
Bulletin 95	Dandelions, Hawkweeds, Ginseng, Cankerworms.....	W. M. Munson.

Station publications received by the Office of Experiment Stations during 1903—Continued.

MARYLAND STATION.

Publication.	Title.	Author.
1902.		
Bulletin 87	The Periodical Cicada or Seventeen-year Locust	A. L. Quaintance.
1903.		
Bulletin 88	Economical Methods for Improving the Keeping Qualities of Milk.	C. F. Donne.
Bulletin 89	Experiments with Potash as a Fertilizer.	H. J. Patterson.
Annual Report	Sixteenth Annual Report, 1903.	

MASSACHUSETTS STATION.

1902.		
Annual Report	Fifteenth Annual Report, 1902.	
1903.		
Bulletin 85	Concentrated Feeds	J. B. Lindsey et al.
Bulletin 86	Orchard Treatment for the San José Scale. One Year's Experiments in Massachusetts.	H. T. Fernald.
Bulletin 87	Cucumbers under Glass	G. E. Stone.
Bulletin 88	A Catalogue of the Coccidie of the World	Maria E. Fernald.
Bulletin 89	Analyses of Commercial Fertilizers and Manurial Substances.	C. A. Goessmann.
Bulletin 90	do.	do.
Bulletin 91	Injuries to Shade Trees from Electricity.	G. E. Stone.
Meteorological Bulletins.	Meteorological Bulletins 169-173.	J. E. Ostrander and S. C. Bacon.
	Meteorological Bulletins 174-180.	J. E. Ostrander and F. F. Henshaw.
Bulletin 92	Analyses of Commercial Fertilizers and Manurial Substances.	C. A. Goessmann.
Technical Bulletin 1.	The Greenhouse Aleurodes and the Strawberry Aleurodes; A Study of the Insects and of their Treatment.	A. W. Morrill.

MICHIGAN STATION.

1902.		
Bulletin 203.	Analyses of Some of the Commercial Feeding Stuffs of Michigan.	F. W. Robison.
Annual Report	Fifteenth Annual Report, 1902.	
1903.		
Bulletin 204.	Mosquitoes and other Insects of the Year 1902.	R. H. Pettit.
Bulletin 205.	Report of South Haven Substation	T. A. Ferrand.
Bulletin 206.	Notes on Small Fruits	M. L. Dean.
Bulletin 207.	Sugar Beet Experiments, 1902.	C. D. Smith.
Bulletin 208.	Michigan Mushrooms.	B. O. Longyear.
Bulletin 209.	Vegetables and Bush Fruits	L. R. Taft and M. L. Dean.
Bulletin 210.	Fertilizer Analyses	F. W. Robison.
Special Bulletin 17.	Mosquitoes and other Insects of the Year 1902.	R. H. Pettit.
Special Bulletin 18.	Sugar Beets in the Upper Peninsula	C. D. Smith and L. M. Gelsmar.
Special Bulletin 19.	Spraying Calendar.	L. R. Taft and C. D. Smith.
Special Bulletin 20.	Report of the Upper Peninsula Substation for the Years 1901 and 1902.	C. D. Smith and L. M. Gelsmar.
Special Bulletin 21.	Cheese Problems.	J. Michels.

Station publications received by the Office of Experiment Stations during 1903—Continued.

MINNESOTA STATION.

Publication.	Title.	Author.
1902.		
Bulletin 75.....	Fattening Lambs	T. Shaw.
Bulletin 76.....	Fattening Steers	Do.
Bulletin 77.....	Insects Notably Injurious in 1902.....	F. L. Washburn.
Annual Report....	Tenth Annual Report, 1902.....	
1903.		
Bulletin 78.....	Experiments in Sheep Husbandry.....	T. Shaw.
Bulletin 79.....	Investigation in Milk Production.....	T. L. Haecker.
Bulletin 80.....	Alfalfa, Its Chemical Development, Feeding Value, and Digestibility. The Digestibility of Hog Millet.	H. Snyder and J. A. Hummel.
Bulletin 81.....	Review of the Work of the Northeast Experiment Farm since its Organization in May, 1896.	H. H. Chapman.
Bulletin 82.....	Hemorrhagic Septicemia.....	M. H. Reynolds.
Bulletin 83.....	Apples and Apple Growing in Minnesota.....	S. B. Green.

MISSISSIPPI STATION.

1902.		
Bulletin 78	The Chicken Mite	G. W. Herrick.
1903.		
Bulletin 79	Report of Work at McNeill Branch Station for 1902.....	E. B. Ferris.
Bulletin 80	Farmers' Institute Bulletin, 1902.....	
Annual Report	Sixteenth Annual Report, 1903.....	

MISSOURI FRUIT STATION.

1902.		
Bulletin 4	Winter Treatment of Orchards and Notes on Cultivation.	F. W. Faurot and J. T. Stinson.
Bulletin 5	Notes on Spraying and Spraying Machinery	Do.
Biennial report....	Second Biennial Report, 1901-2.....	
1903.		
Bulletin 6	Report on Fungus Diseases occurring on Cultivated Fruits.	F. W. Faurot.
Bulletin 7	Strawberry Culture.....	P. Evans and F. W. Faurot.

MISSOURI STATION.

1902.		
Bulletin 57	Raising Calves with Skim Milk.....	C. H. Eckles.
Bulletin 58	Feeding the Dairy Cow	Do.
Bulletin 59	Corn Improvement for Missouri	G. M. Tucker.
Circular 10	Spray Calendar.....	M. O. Booth.
Circular 11	Corn as a Stock Food	H. J. Waters.
Circular 12	Factors in Beef Production.....	F. B. Mumford.
Circular 13	Plant Propagation	W. L. Howard.
1903.		
Bulletin 60	A New Bordeaux Powder	R. M. Bird.
Bulletin 61	Apple Growing in Missouri	J. C. Whitman.
Bulletin 62	Hessian Fly in Missouri	J. M. Steelman.
Circular 14	Commercial Fruit Evaporators	J. C. Whitman and L. A. Goodman.
Circular 15	The Principles of Plant Production	F. B. Mumford.
Circular 16	Report on the Enforcement of the Fertilizer Control Law.	H. J. Waters.

Station publications received by the Office of Experiment Stations during 1903—Continued.

MONTANA STATION.

Publication.	Title.	Author.
1902.		
Bulletin 37	Pork Production in Montana	R. S. Shaw.
Bulletin 38	Food Adulteration	F. W. Traphagen.
Bulletin 39	Sheep Feeding in Montana	R. S. Shaw.
Bulletin 40	Root Crops in Montana	Do.
Bulletin 41	Sugar Beets	F. W. Traphagen.
Bulletin 42	The Codling Moth	R. A. Cooley.
Annual Report....	Ninth Annual Report, 1902	
1903.		
Bulletin 43	Duty of Water in Montana.....	S. Fortier.
Bulletin 44	Apple Growing in Montana.....	R. W. Fisher.
Bulletin 45	The Loco and some other Poisonous Plants in Montana.....	J. W. Blankinship.
Bulletin 46	Two Insect Pests.....	R. A. Cooley.
Bulletin 47	Sheep Feeding.....	F. B. Lintfield.
Bulletin 48	Steer Feeding.....	Do.

NEBRASKA STATION.

1902.		
Annual Report....	Sixteenth Annual Report, 1902	
1903.		
Bulletin 76	Experiments with Dairy Herd.....	A. L. Haecker.
Bulletin 77	Poisoning of Cattle by Common Sorghum and Kafir Corn.....	A. T. Peters, H. B. Slade, and S. Avery.
Bulletin 78	Macaroni W heats	T. L. Lyon.
Bulletin 79	Experiments in Orchard Culture	R. A. Emerson.
Bulletin 80	Experiment in Mulching Garden Vegetables.....	Do.
Bulletin 81	Experiments in the Culture of the Sugar Beet in Nebraska.....	T. L. Lyon and A. T. Wiancko.

NEVADA STATION.

1902.		
Bulletin 54	Report of Irrigation Investigations, Humboldt River Valley, Nevada.....	J. D. Stannard.
Annual Report....	Annual Report, 1902	

NEW HAMPSHIRE STATION.

1902.		
Bulletin 94	Remedies for Fleas.....	A. F. Conradi.
Bulletin 95	How to Grow a Forest from Seed	F. W. Rane.
Bulletin 96	Fourteenth Annual Report, 1902	
Technical Bul. 4....	Effect of Acetylene Gaslight on Plant Growth.....	Do.
Technical Bul. 5....	A Partial Bibliography of the Economic Relations of North American Birds.....	C. M. Weed.
1903.		
Technical Bul. 6....	A Study of the Parasites of the American Tent Caterpillar.....	W. F. Fiske.
Bulletin 97	Inspection of Fertilizers in 1902.....	F. W. Morse et al.
Bulletin 98	The Inspection of Feeding Stuffs in 1902	Do.
Bulletin 99	A Selected List of Vegetables for the Garden.....	F. W. Rane.
Bulletin 100	The White Fly of Greenhouses	C. M. Weed and A. F. Conradi.
Bulletin 101	Fungus Diseases and Spraying.....	H. H. Lamson.

Station publications received by the Office of Experiment Stations during 1903—Continued.

NEW JERSEY STATIONS.

Publication.	Title.	Author.
1902.		
Bulletin 162	Lime, Salt, and Sulphur Wash.....	J. B. Smith.
Bulletin 163	Analyses and Valuations of Commercial Fertilizers and Ground Bone.	L. A. Voorhees and J. P. Street.
Annual Report	Twenty-third Annual Report of the State Station and Fifteenth Annual Report of the College Station, 1902.	
1903.		
Bulletin 164	Field Experiments with Nitrate of Soda on Forage Crops and on Market Garden Crops.	E. B. Voorhees.
Bulletin 165	Concentrated Feeding Stuffs.....	L. A. Voorhees and J. P. Street.
Bulletin 166	The Proper Disposal of Sewerage Wastes in Rural Districts.	J. Nelson.
Bulletin 167	Some of the Newer Fungicides	B. D. Halsted and J. A. Kelsey.
Bulletin 168	Analyses and Valuations of Commercial Fertilizers and Ground Bone.	J. P. Street, W. P. Allen, and V. J. Carberry.

NEW MEXICO STATION.

1902.		
Annual Report	Thirteenth Annual Report, 1902	
1903.		
Bulletin 44	Ash Analyses of Some New Mexico Plants	A. Goss.
Bulletin 45	Pumping for Irrigation from Wells.....	J. J. Vernon and F. E. Lester.
Bulletin 46	Soil Moisture Investigations for the Seasons of 1901 and 1902.	J. J. Vernon and J. D. Tinsley.
Bulletin 47	Shade Trees and Other Ornamentals	F. Garcia.

NEW YORK STATE STATION.

1901.		
Annual Report	Twentieth Annual Report, 1901.....	
1902.		
Bulletin 217	Inspection of Feeding Stuffs.....	W. H. Jordan, C. G. Jenter, and F. D. Fuller.
Bulletin 218	Variety Tests of Strawberries.....	O. M. Taylor.
Bulletin 219	Some of the Compounds Present in American Cheddar Cheese.	L. L. Van Slyke and E. B. Hart.
Bulletin 220	Two Unusual Troubles of Apple Foliage.....	F. C. Stewart and H. J. Eustace.
Bulletin 221	Potato Spraying Experiments in 1902.....	F. C. Stewart, H. J. Eustace, and F. A. Serrine.
Bulletin 222	Report of Analyses of Paris Green and other Insecticides in 1902.	L. L. Van Slyke and W. H. Andrews.
Bulletin 223	Investigations Concerning the Self-Fertility of the Grape, 1900-1902—Parts I and II.	S. A. Beach.
Bulletin 224	Investigations Concerning the Self-Fertility of the Grape, 1900-1902—Part III.	N. O. Booth.
Bulletin 225	Control of Rusty Spot in Cheese Factories.....	H. A. Harding and G. A. Smith.
Bulletin 226	Raspberry Cane Blight and Raspberry Yellows.....	F. C. Stewart and H. J. Eustace.
Bulletin 227	A Destructive Apple Rot Following Scab.....	H. J. Eustace.
Bulletin 228	San José Scale Investigations—Part IV.....	V. H. Lowe and P. J. Parrott.
Bulletin 229	Director's Report for 1902.....	W. H. Jordan.

Station publications received by the Office of Experiment Stations during 1903—Continued.

NEW YORK STATE STATION—Continued.

Publication.	Title.	Author.
1903.		
Bulletin 230	Some Facts About Commercial Fertilizers in New York State.	L. L. Van Slyke.
Bulletin 231	The Relation of Carbon-dioxid to Proteolysis in the Ripening of Cheddar Cheese.	L. L. Van Slyke and E. B. Hart.
Bulletin 232	Combating the Black Rot of Cabbage by the Removal of Affected Leaves.	F. C. Stewart and H. A. Harding.
Bulletin 233	Rennet-Enzym as a Factor in Cheese Ripening	L. L. Van Slyke, H. A. Harding, and E. B. Hart.
Bulletin 234	Experiments in Curing Cheese at Different Temperatures.	L. L. Van Slyke, G. A. Smith, and E. B. Hart.
Bulletin 235	Two Decays of Stored Apples	H. J. Eustace.
Bulletin 236	Conditions affecting Chemical Changes in Cheese Ripening.	L. L. Van Slyke and E. B. Hart.
Bulletin 237	The Role of the Lactic-Acid Bacteria in the Manufacture and in the Early Stages of Ripening of Cheddar Cheese.	H. A. Harding.
Bulletin 238	The Status of Phosphorus in Certain Food Materials and Animal By-Products with Special Reference to Inorganic Forms.	E. B. Hart and W. H. Andrews.
Bulletin 239	Thinning Apples	S. A. Beach.
Bulletin 240	Inspection of Feeding Stuffs	W. H. Jordan and F. D. Fuller.

NEW YORK CORNELL STATION.

1902.		
Bulletin 208	The Grape-Root Worm	M. V. Slingerland and J. Craig.
Annual Report	Fifteenth Annual Report, 1902.....	
1903.		
Bulletin 209	Distinctive Characteristics of the Species of the Genus <i>Lecanium</i> .	W. C. Thro.
Bulletin 210	Commercial Bean Growing in New York	J. L. Stone.
Bulletin 211	Cooperative Poultry Experiments: The Yearly Record of Three Flocks.	H. H. Wing.
Bulletin 212	Second Report on Cooperative Records on the Cost of Producing Eggs.	Do.
Bulletin 213	Methods of Milking	H. H. Wing and J. A. Foord.

NORTH CAROLINA STATION.

1902.		
Annual Report	Twenty-Fifth Annual Report, 1902.....	
1903.		
Bulletin 182	The Apple: Propagation, Planting, Pruning, and Culture	W. F. Massey.
	Apples in North Carolina. Preparing Apples for Market.	T. K. Bruner.
	How to Utilize the Surplus Apple Crop. Cider Vinegar.	G. McCarthy.
Bulletin 183	Insect and Fungus Enemies of the Apple, Pear, and Quince, with Methods of Treatment.	F. L. Stevens and F. Sherman, jr.
Bulletin 184	The Culture and Marketing of Orchard and Garden Fruits.	W. F. Massey.
Bulletin 185	The Black Rot of the Grape in North Carolina, and Its Treatment.	A. W. Edson.
Bulletin 186	Insect and Fungus Enemies of the Peach, Plum, Cherry, Fig, and Persimmon.	F. Sherman, jr., and F. L. Stevens.
Bulletin 187	Grapes and Small Fruits	W. F. Massey.
Bulletin 188	The Granville Tobacco Wilt; A Preliminary Bulletin....	F. L. Stevens and W. G. Sackett.

Station publications received by the Office of Experiment Stations during 1903—Continued.

NORTH DAKOTA STATION.

Publication.	Title.	Author.
1902.		
Bulletin 53.....	Food Products and their Adulteration	E. F. Ladd.
Bulletin 54.....	Abortion in Cattle. Scours in New-Born Calves	L. Van Es.
Annual Report	Thirteenth Annual Report, 1902	
1903.		
Bulletin 55.....	Flax and Flax-Seed Selection	H. L. Bolley.
Bulletin 56.....	Noxious Weeds and How to Kill Them	L. R. Waldron.
Bulletin 57.....	Some Food Products and Food Adulteration	E. F. Ladd et al.
Special Bulletin 1.....	Pure Food Law and Rulings of the Food Commissioner	E. F. Ladd.
Special Bulletin 2.....	Weeds	L. R. Waldron.

OHIO STATION.

1902.		
Bulletin 135.....	Twenty-First Annual Report, 1902. Meteorological Summary, 1901. Press Bulletins. Index.	
Bulletin 136.....	The Hessian Fly in Ohio.....	C. E. Thorne.
1903.		
Bulletin 137.....	Suggestions Concerning Apple Culture	W. J. Green.
Bulletin 138.....	Experiments with Oats	C. G. Williams.
Bulletin 139.....	A Rosette Disease of Potatoes.....	A. D. Selby.
Bulletin 140.....	The Corn Crop.....	C. G. Williams.
Bulletin 141.....	The Maintenance of Fertility.....	C. E. Thorne.

OKLAHOMA STATION.

1902.		
Bulletin 55.....	Bermuda Grass	J. Fields.
Bulletin 56.....	Garden Vegetables	O. M. Morris.
1903.		
Bulletin 57.....	Directions for using Vaccine for the Prevention of Black-leg in Cattle.	L. L. Lewis.
Bulletin 58.....	Fattening Steers; Using Cotton Seed, Cotton-Seed Meal, Wheat Straw, and Hay.	F. C. Burtis and J. Fields.
Bulletin 59.....	Reprints from Bulletins Nos. 47, 50, and 52, and Annual Reports 8 to 11.	
Annual Report.....	Twelfth Annual Report, 1903	

OREGON STATION.

1902.		
Bulletin 73.....	Notes on Vinegar Making	E. F. Pernot.
1903.		
Bulletin 74.....	The Cultivation of Vegetables and Notes on Varieties....	G. Coote.
Bulletin 75	Insecticides and Fungicides	A. B. Cordley.
Bulletin 76	Leguminous Forage Plants	J. Withycombe.

PENNSYLVANIA STATION.

1902.		
Bulletin 61	Annual Report of the Director.....	H. P. Armsby.
Annual Report	Annual Report, 1902	
1903.		
Bulletin 62	An Experiment in Ginseng Culture	G. C. Butz.
Bulletin 63	Losses in Manure	W. Frear.

Station publications received by the Office of Experiment Stations during 1903—Continued.

PORTO RICO STATION.

Publication.	Title.	Author.
1902.		
Annual Report	Second Annual Report, 1902	F. D. Gardner.
1903.		
Bulletin 3	Soil Survey from Arecibo to Ponce, Porto Rico	C. W. Dorsey, L. Mesmer, and T. A. Guine.

RHODE ISLAND STATION.

1902.		
Bulletin 86	Goose Septicemia	C. Curtice.
Bulletin 87	Fowl Typhoid	Do.
Bulletin 88	The Forests of Rhode Island	F. W. Card.
Bulletin 89	Commercial Fertilizers	H. J. Wheeler and B. L. Hartwell.
Annual Report	Fifteenth Annual Report, 1902.	
1903.		
Bulletin 90	Further Experiments in Top-Dressing Grass Land.	H. J. Wheeler and G. E. Adams.
Bulletin 91	Bush Fruits	F. W. Card.
Bulletin 92	The Soy Bean	G. E. Adams.
Bulletin 93	Commercial Fertilizers	H. J. Wheeler et al.
Bulletin 94	Commercial Feeding Stuffs	H. J. Wheeler, A. W. Bosworth, and J. W. Kellogg.
Bulletin 95	Cooperative Experiments in Top-Dressing Grass Land.	H. J. Wheeler.
Bulletin 96	Influence of Lime upon Plant Growth	H. J. Wheeler and G. E. Adams.
Bulletin 97	Commercial Fertilizers	H. J. Wheeler et al.

SOUTH CAROLINA STATION.

1902.		
Bulletin 72.	Texas Fever	G. E. Nesom.
Bulletin 73.	Analyses of Commercial Fertilizers, Season of 1901-2—Part II.	
Bulletin 74.	Experiments with Poultry	O. M. Watson.
Bulletin 75.	Cotton Culture	J. S. Newman.
Bulletin 76.	Bermuda Grass	Do.
Bulletin 77.	The Standardization of Sulphuric Acid	F. S. Shiver.
Bulletin 78.	The Nature, Determination, and Distribution of the Pentosans in the Sea Island Cotton.	Do.
Annual Report	Fifteenth Annual Report, 1902.	
1903.		
Bulletin 79.	A Rotation Study	Do.
Bulletin 80.	Analyses of Commercial Fertilizers, Season of 1902-3—Part I.	M. B. Hardin.
Bulletin 81.	Artificial Incubation of Chickens	O. M. Watson.
Bulletin 82.	Analyses of Commercial Fertilizers, Season of 1902-3—Part II.	

SOUTH DAKOTA STATION.

1901.		
Annual Report	Annual Report, 1901	
1902.		
Bulletin 75.	Treatment of Smuts and Rusts	D. A. Saunders.
Bulletin 76.	A Study of Northwestern Apples	N. E. Hansen.
Bulletin 77.	Macaroni Wheat in South Dakota	E. C. Chilcott et al.
Annual Report	Annual Report, 1902	

Station publications received by the Office of Experiment Stations during 1903—Continued.

SOUTH DAKOTA STATION—Continued.

Publication.	Title.	Author.
1903.		
Bulletin 78.....	A Preliminary Report on the Fringed Tapeworm of Sheep.	E. L. Moore.
Bulletin 79.....	Crop Rotation for South Dakota.....	E. C. Chilcott.
Bulletin 80.....	Lamb Feeding.....	J. W. Wilson and H. G. Skinner.
Bulletin 81.....	Fattening Sheep on Grass.....	Do.
	Pasture and Forage Plants for South Dakota.....	E. C. Chilcott.
	Feeding Dairy Cows.....	J. W. Wilson and H. G. Skinner.
	Flies.....	E. L. Moore.
	The Artesian Waters of South Dakota.....	J. H. Shepard.
	Some Destructive Insects.....	D. A. Saunders.
	Elements of Prairie Horticulture.....	N. E. Hansen.
Annual Report....	Annual Report, 1903.....	

TENNESSEE STATION.

1902.		
Annual Report....	Fifteenth Annual Report, 1902.....	
1903.		
Bul. Vol. XVI, No. 1	Fertilizer Experiments.....	C. A. Moores.
Bul. Vol. XVI, No. 2	San José Scale.....	C. A. Keffer.
Bul. Vol. XVI, No. 3	Corn, Wheat, and Soy-Bean Meal with Skim Milk for Pork Production.	A. M. Soule and J. R. Fain.
Bul. Vol. XVI, No. 4	Influence of Climate and Soil on the Composition and Milling Qualities of Winter Wheat.	A. M. Soule and P. O. Vanatter.

TEXAS STATION.

1902.		
Annual Report....	Fourteenth Annual Report, 1902.....	
1903.		
Bulletin 65.....	The Tomato.....	E. J. Kyle and E. C. Green.
Bulletin 66.....	Alfalfa, Peanuts, Velvet Beans, Millet, Rape.....	B. C. Pittuck.
Bulletin 67.....	Commercial Fertilizers and Commercial Poisonous Insecticides.	H. H. Harrington.
Bulletin 68.....	The Manufacture of Cane Sirup.....	Do.
Bulletin 69.....	Cabbage: Test of Varieties and Fertilizers.....	B. C. Pittuck and S. A. McHenry.

UTAH STATION.

1902.		
Bulletin 78.....	Experiments in Fattening Lambs.....	F. E. Linfield.
Bulletin 79.....	Process Butter.....	R. W. Clark and J. A. Crockett.
Bulletin 80.....	Irrigation Investigations in 1901.....	
1903.		
Bulletin 81.....	Poison in Water from a Gold and Silver Mill.....	P. A. Yoder.
Bulletin 82.....	Feeding Beet Pulp to Steers and Sheep.....	R. W. Clark.

Station publications received by the Office of Experiment Stations during 1903—Continued.

VERMONT STATION.

Publication.	Title.	Author.
1902.		
Bulletin 98	Analyses of Commercial Fertilizers	J. L. Hills and C. H. Jones.
Annual Report....	Fifteenth Annual Report, 1902	
1903.		
Bulletin 99	Commercial Fertilizers	Do.
Bulletin 100	Paying for Separator Cream at the Creamery.....	J. L. Hills.
Bulletin 101	Commercial Feeding Stuffs.....	J. L. Hills, C. H. Jones, and F. M. Hollister.

VIRGINIA STATION.

1901.		
Bulletin 129.....	Orchard Studies II. The Fruit Plantation—Stone Fruits.	W. B. Alwood.
Bulletin 130.....	Orchard Studies III. Notes on Some of the More Important Varieties of Apples.	Do.
Bulletin 131.....	Orchard Studies IV. Remedial Measures Against San José Scale.	Do.
1902.		
Bulletin 132.....	Orchard Studies V. Report on Crab Apples.....	W. B. Alwood and H. L. Price.
Bulletin 133.....	Orchard Studies VI. Second Report on the Cherry Orchard.	Do.
Bulletin 134.....	Orchard Studies VII. Spraying the Plum Orchard. Notes on the Varieties of Domestic Plums.	Do.
Bulletin 135.....	Orchard Studies VIII. On the Occurrence and Treatment of Fire Blight in the Pear Orchard.	W. B. Alwood.
Bulletin 136.....	Orchard Studies IX. An Investigation into the Character of Cider Apples in Europe and Comparisons with American Fruit.	Do.
Bulletin 137.....	Orchard Studies X. A Consideration of the Commercial Handling of Cider Fruit.	Do.
Bulletin 138.....	Orchard Studies XI. A Consideration of the Principles and Technique Involved in the Fermentation and Final Finishing of Ciders.	Do.
Bulletin 139.....	Orchard Studies XII. The Chemical Composition of Ciders.	Do.
Bulletin 140.....	Orchard Studies XIII. Some Observation on Crown Gall of Apple Trees.	Do.
Bulletin 141.....	Orchard Studies XIV. The Lime-Sulphur Wash.....	W. B. Alwood and J. L. Phillips.
Bulletin 142.....	Orchard Studies XV. The Bitter Rot of Apples.....	W. B. Alwood.
Annual Report	Annual Report, 1902	
1903.		
Bulletin 144.....	Stock and Poultry Powders or Condimental Foods.....	D. O. Nourse and M. Ferguson.
Bulletin 145.....	Forage Plants.....	D. O. Nourse.
Bulletin 146.....	Some Notes on Canning Fruits and Vegetables.....	W. B. Alwood.
Bulletin 147.....	Bush Fruits, Second Report.....	H. L. Price.

WASHINGTON STATION.

1902.		
Bulletin 54.....	The Formalin Treatment for Wheat and Oat Smut.....	R. K. Beattie.
Bulletin 55.....	Washington Soils.....	E. Fulmer.
1903.		
Bulletin 56.....	Spraying for the San José Scale with Modifications of the Sulphur-Salt-Lime Wash. Chemical Notes on the Sulphur-Salt-Lime Wash.....	C. V. Piper.
Bulletin 57.....	Home Vegetable Garden in the Palouse Country.....	R. W. Fletcher.
Bulletin 58.....	Experiments in Feeding Swine.....	S. W. Fletcher.
Bulletin 59.....	Root Diseases of Fruit and Other Trees Caused by Tonal Stools.	E. E. Elliott. C. V. Piper and S. W. Fletcher.

Station publications received by the Office of Experiment Stations during 1903—Continued.

WEST VIRGINIA STATION.

Publication.	Title.	Author.
1902.		
Bulletin 81.....	Vegetable Gardening in the Mountain Glades.....	L. C. Corbett and K. C. Davis.
Bulletin 82.....	Peach Growing in West Virginia.....	K. C. Davis.
Bulletin 83.....	Poultry Experiments.....	J. H. Stewart and H. Atwood.
1903.		
Bulletin 84.....	Experiments with Buckwheat and Oats.....	Do.
Bulletin 85.....	Commercial Fertilizers.....	J. H. Stewart and B. H. Hite.
Bulletin 86.....	Cranberries in West Virginia.....	L. C. Corbett.
Bulletin 87.....	Greenhouses.....	Do.
Special Report.....	Report of the Nursery Inspection Work of the Station for the Years 1901 and 1902.	J. H. Stewart.

WISCONSIN STATION.

1902.		
Bulletin 96.....	Investigations of Methods of Milking.....	F. W. Woll.
Bulletin 97.....	Licensed Commercial Feeding Stuffs, 1902.....	F. W. Woll and G. A. Olsen.
Annual Report....	Nineteenth Annual Report, 1902.....	
1903.		
Bulletin 98.....	On the Prevention of Oat Smut and Potato Scab.....	R. A. Moore.
Bulletin 99.....	Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1903.	F. W. Woll.
Bulletin 100.....	Licensed Fertilizers and Feeding Stuffs, 1903.....	F. W. Woll and G. A. Olsen.
Bulletin 101.....	Shrinkage of Cold-Cured Cheese During Ripening.....	S. M. Babcock, H. L. Russell, and U. S. Baer.
Bulletin 102.....	Studies in Milk Production.....	W. L. Carlyle and F. W. Woll.
Bulletin 103.....	Soiling Crops for Dairy Cows in Wisconsin.....	W. L. Carlyle, J. R. Danks, and G. E. Morton.
Bulletin 104.....	The Food Requirements of Pigs from Birth to Maturity..	W. L. Carlyle.

WYOMING STATION.

1902.		
Index Bulletin C..	Index to Bulletins 38 to 53 and Annual Reports, 1891-1902.	G. R. Hebard.
1903.		
Bulletin 56.....	Food Adulteration in Wyoming.....	E. E. Slosson.
Bulletin 57.....	Shade Tree Suggestions.....	A. Nelson.
Bulletin 58.....	Growing and Preparing Agricultural Products for Exhibition.	B. C. Buffum and A. Nelson.
Annual Report....	Thirteenth Annual Report, 1903.....	

STATISTICS OF LAND-GRANT COLLEGES AND AGRICULTURAL EXPERIMENT STATIONS, 1903.

Compiled by Miss M. T. SPETHMANN.

The following statistical statements relate to the institutions established under the acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses of instruction in agriculture, and to the agricultural experiment stations, which, with a few exceptions, are organized under the act of Congress of March 2, 1887, and are conducted as departments of the institutions receiving the benefits of the land-grant act of July 2, 1862. These statistics have been compiled in part from replies to a circular of inquiry sent out from the Office of Experiment Stations, and in part from the annual reports of the presidents of these institutions made on the schedules prescribed by the Commissioner of Education. Tables showing the annual disbursements on account of the acts of Congress of March 2, 1887, and August 30, 1890, prepared in the Departments of the Treasury and the Interior, are also included. Owing to the complex organization of many of the institutions, it is impracticable to give exactly comparable statistics in all cases, and in some instances the data furnished are incomplete.

SUMMARY OF STATISTICS OF LAND-GRANT COLLEGES.

Educational institutions receiving the benefits of the acts of Congress of July 2, 1862, and August 30, 1890, are now in operation in all the States and Territories except Alaska, Hawaii, and Porto Rico. The total number of these institutions is 65, of which 63 maintain courses of instruction in agriculture. The aggregate value of the permanent funds and equipment of the land-grant colleges and universities in 1903 is estimated to be as follows: Land-grant fund of 1862, \$11,140,890.51; other land-grant funds, \$2,849,293.49; other permanent funds, \$14,926,747.49; land grant of 1862 still unsold, \$4,292,460.26; farm and grounds owned by the institutions, \$5,610,441.03; buildings, \$21,246,159.88; apparatus, \$2,379,742.28; machinery, \$1,112,805.28; libraries, \$2,114,802.60; live stock, \$252,490.66; miscellaneous equipment, \$3,852,629.77; total, \$69,778,463.25. The income of these institutions in

1903, exclusive of the funds received from the United States for agricultural experiment stations (\$719,999.50), was as follows: Interest on land grant of 1862, \$674,174.77; interest on other land grants, \$84,903.31; United States appropriation under act of 1890, \$1,200,000; interest on endowment or regular appropriation, \$278,409.25; State appropriation for current expenses, \$2,469,848.44; State appropriation for buildings or other special purposes, \$1,577,927.40; endowment, other than Federal or State grants, \$602,802.41; tuition fees, \$944,826.07; incidental fees, \$294,492.95; miscellaneous, \$1,120,993.80; total, \$9,248,378.40. The value of the additions to the permanent endowment and equipment of these institutions in 1903 is estimated as follows: Permanent endowment, \$626,916.56; buildings, \$1,426,330.31; libraries, \$135,312.46; apparatus, \$104,247.94; machinery, \$169,182.24; live stock, \$51,140.96; miscellaneous, \$230,552.91; total, \$2,743,683.38.

The number of persons in the faculties of the colleges of agriculture and mechanical arts was as follows: For preparatory classes, 445; for collegiate and special classes, 2,024; total, 2,461. In the other departments the faculties aggregate 1,141, making a grand total of 3,602 persons in the faculties of the land-grant institutions. The students in 1903 were as follows: (1) By classes—preparatory, 8,801; collegiate classes, 19,161; short course or special, 7,999; post-graduate, 607; other departments, 16,760; total, 52,489. (2) By courses: *Four-year*—agriculture, 3,146; horticulture, 539; household economy, 873; mechanical engineering, 4,475; civil engineering, 2,587; electrical engineering, 2,116; mining engineering, 955; chemical engineering, 188; architecture, 182. *Shorter*—agriculture, 5,505; dairying, 867; horticulture, 367; veterinary science, 811; military tactics, 16,316. The graduates in 1903 were 4,524, and since the organization of these institutions, 53,252. The average age of graduates in 1903 was 21 years and 10 months. The total number of volumes in the libraries was 1,837,461. The total number of acres of land granted to the States under the act of 1862 was 10,170,851, of which 1,007,994 are still unsold.

SUMMARY OF STATISTICS OF STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories, and under special appropriation acts in Alaska, Hawaii, and Porto Rico.

In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 55 receive appropriations provided for by acts of Congress.

The total income of the stations maintained under the act of 1887 during 1903 was \$1,427,237.73, of which \$720,000 was received from the National Government, the remainder, \$707,237.73, coming from the following sources: State governments, \$431,262.41; individuals and communities, \$10,660; fees for analyses of fertilizers, \$99,864.23; sales from farm products, \$105,128.02; miscellaneous, \$60,323.07. In addition to this the Office of Experiment Stations had an appropriation of \$161,000 for the past fiscal year, including \$15,000 for the Alaska Experiment Stations, \$12,000 for the Hawaii Experiment Station, \$12,000 for the Porto Rico Experiment Station, \$20,000 for nutrition investigations, and \$65,000 for irrigation investigations. The value of additions to the equipment of the stations in 1903 is estimated as follows: Buildings, \$135,581.16; libraries, \$11,501.35; apparatus, \$18,552.41; farm implements, \$15,123.98; live stock, \$22,427.82; miscellaneous, \$33,183.89; total, \$236,370.61.

The stations employ 757 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 54; assistant and vice-directors, 19; special agents in charge, 3; chemists, 160; agriculturists, 54; agronomists, 27; animal husbandmen, 39; poultrymen, 7; horticulturists, 79; farm and garden foremen, 39; dairymen, 34; botanists, 56; plant pathologists, 4; entomologists, 50; zoologists, 6; veterinarians, 31; meteorologists, 10; biologists, 6; physicists, 6; geologists, 4; mycologists and bacteriologists, 23; irrigation engineers, 11; in charge of substations, 16; secretaries and treasurers, 27; librarians, 12; clerks and stenographers, 34. There are also 50 persons classified under the head of "Miscellaneous," including superintendents of grounds and buildings, apiarists, herdsmen, etc. Three hundred and seventy-five station officers do more or less teaching in the colleges with which the stations are connected. During the year the stations published 371 annual reports and bulletins which were supplied to over half a million addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins and other special publications, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

STATISTICS OF THE LAND-GRANT

Unless otherwise specified, the statistics reported in the tables are

TABLE 1.—*Institutions established under the land-*
[All of the institutions in this list, except those marked with

State or Territory.	Name of institution.	Location.	President.
Alabama	Alabama Polytechnic Institute.	Auburn	C. C. Thach, M. A.
	Agricultural and Mechanical College for Negroes.	Normal	W. H. Council, Ph. D.
Arizona	University of Arizona	Tucson	K. C. Babcock, Ph. D.
Arkansas	University of Arkansas	Fayetteville	H. S. Hartzog, LL. D.
	* Branch Normal College	Pine Bluff	Isaac Fisher
California	University of California	Berkeley	B. I. Wheeler, Ph. D., LL. D. .
Colorado	The State Agricultural College of Colorado.	Fort Collins	B. O. Aylesworth, M. A., LL. D. .
Connecticut	Connecticut Agricultural College.	Storrs	R. W. Stimson, M. A., B. D. .
Delaware	Delaware College	Newark	G. A. Harter, M. A., Ph. D. .
	State College for Colored Students.	Dover	W. C. Jason, M. A., B. D.
Florida	University of Florida	Lake City	T. H. Taliaferro, C. E., Ph. D. .
	Florida State Normal and Industrial School.	Tallahassee	N. B. Young, M. A.
Georgia	Georgia State College of Agriculture and Mechanic Arts.	Athens	H. C. White, Ph. D.
	Georgia State Industrial College.	College	R. R. Wright, M. A., LL. D. .
Idaho	University of Idaho	Moscow	J. A. McLean, Ph. D.
Illinois	University of Illinois	Urbana	A. S. Draper, LL. D.
Indiana	Purdue University	Lafayette	W. E. Stone, Ph. D.
Iowa	Iowa State College of Agriculture and the Mechanic Arts.	Ames	A. B. Storms, M. A., D. D.
Kansas	Kansas State Agricultural College.	Manhattan	E. R. Nichols, M. A.
Kentucky	Agricultural and Mechanical College of Kentucky.	Lexington	J. K. Patterson, Ph. D., LL. D. .
	The Kentucky Normal and Industrial Institute for Colored Persons.	Frankfort	J. S. Hathaway, M. A., M. D. .
Louisiana	Louisiana State University and Agricultural and Mechanical College.	Baton Rouge	T. D. Boyd, M. A., LL. D.
	Southern University and Agricultural and Mechanical College.	New Orleans	H. A. Hill
Maine	The University of Maine	Orono	G. E. Fellows, M. A., Ph. D. .
Maryland	Maryland Agricultural College.	College Park	R. W. Silvester
Massachusetts	Princess Anne Academy	Princess Anne	Frank Trigg, M. A.
	Massachusetts Agricultural College.	Amherst	H. H. Goodell, LL. D.
	* Massachusetts Institute of Technology.	Boston	H. S. Pritchett

a Including also institutions receiving appro

COLLEGES AND UNIVERSITIES. ^a

for the institutions as designated in the list given below:

grant act of July 2, 1862, and their courses of study.

an asterisk (*), maintain courses of instruction in agriculture.]

Collegiate courses of study (undergraduate).	
Four-year courses and degrees.	Short courses.
Chem. and agr., civil engin., elect. and mech. en- gin., mining engin., phar., general, chem. and metal. (B. S.).	Agr., mech. arts, phar. (2 yrs.), agr. (1 yr.).
Sci. (B. S.), agr. (B. A. S.), mech. (B. M. S.).....	Indus. and lit. studies (1 to 3 yrs.).
Lit., sci., engin., chem., mining, agr. (B. S.).....	Mining, assaying (2 yrs.), agr. (6 weeks).
Agr. (B. S. A.), mech. engin. (B. M. E.), elect. en- gin. (B. E. E.), civil engin. (B. C. E.), lit. and sci. (B. A. and B. S.).	Mech. engin., elect. engin., normal (2 yrs.).
Collegiate (B. A.).....	Normal, domestic econ., typewriting.
Letters (B. A.), social sci. (B. L.), natural sci., commerce, agr., mech. mining, civil engin., chem. (B. S.).	Prep. med. (3 yrs.), agr. and hort., dairying (10 weeks), summer session (6 weeks).
Agr., mech. engin., civil and irrig. engin., elect. engin., domestic sci., archi., vet. sci. (B. S.). (B. S.).....	Commercial (2 yrs.).
Clas., Lat. sci. (B. A.), agr., general sci. (B. S.), civil engin. (B. C. E.), mech. engin. (B. M. E.), elect. engin. (B. E. E.)	Dairying, creamery, for., pomol. (12 weeks), poul- try (6 weeks), 20 miscellaneous 10-day courses.
Clas. (B. A.), sci. (B. S.), agr. (B. Agr.), engin. (B. E.).	Agr. (2 yrs.), agr. (winter, 10 weeks).
Agr., mech. engin., chem., Lat. sci., civil engin., general sci. (B. S.), clas. (B. A.).	Normal (3 yrs.).
.....	Mech. arts (2 yrs.), business, stenography, and typewriting (1 yr.).
General sci., agr., civil engin., elect. engin. (B. S.).	Normal, academic, and industrial.
Collegiate.....	Agr., hort., dairying (1 yr.), agr. (12 weeks).
Clas. (B. A.), agr., sci., civil engin. (B. S.), min- ing engin. (B. M. E.), music (B. M.).	Normal, industrial, preparatory.
Lit. and arts (B. A.), engin., sci., agr. (B. S.), music (B. M.), libr. sci. (B. L. S.), phar. (Ph. G.), phar. chem. (Ph. C.).	Agr. (2 yrs.), agr. and hort. (6 weeks).
Mech. engin. (B. S., M. E.), civil engin. (B. S., C. E.), elect. engin. (B. S., E. E.), agr. (B. S. Agr.), sci. (B. S.), phar. (B. S. Phar.).	Agr. (2 yrs.), agr., hort., animal husb., dairying (winter, 10 weeks), phar. (2 yrs., Ph. G.).
Agr. (B. S. A.), vet. sci. (D. V. M.), mech. engin. (B. M. E.), civil engin. (B. C. E.), elect. engin. (B. S., E. E.), mining engin. (B. S., M. E.), sci., general and domestic sci. for women (B. S.), tech. (B. S.).	Dairying (1 yr.), dairying (16 weeks), corn judg- ing (2 weeks), stock judging (2 weeks).
Agr., mech. engin., general sci., elect. engin., domestic sci. (B. S.).	Domestic sci. (2 fall terms, 12 weeks each), farmers' (2 winter terms, 12 weeks each), farm dairying (12 weeks), dairying (12 weeks).
Clas. (B. A.), mech. engin. (B. M. E.), civil engin. (B. C. E.), mining engin. (B. M. E.), agr. (B. Agr.), sci. (B. S.), pedag. (B. Ped.).	Agr. (2 yrs.), agr. (winter, 10 weeks).
Normal.....	Normal, agr., carpentry, cooking, dressmaking, printing, blacksmithing, wheelwrighting.
Agr. elect. engin., sugar engin., civil engin., mech., general sci., commercial (B. S.), Lat. sci., lit. (B. A.).	Preparatory (1 yr.), agr. (2 yrs.).
Clas., sci., agr., mech., normal, printing, music..	Agr., dairying, bookkeeping (2 yrs.), mech., tin- smithing (3 yrs.), typewriting.
Clas. (B. A.), Lat. sci. (Ph. B.), sci., agr., for., hort., chem., phar., civil engin., mech. engin., elect. engin., mining engin. (B. S.).	Agr. (2 yrs.), agr. (1 yr.), phar. (2 yrs.), agr. and dairying (6 weeks), poultry management, hort. (3 weeks).
Clas. (B. A.), mech. engin. (B. M. E.), agr., sci. (B. S.).	Agr. (2 yrs.), agr. (10 weeks).
Academic.....	Industrial.
Agr. (B. S.), postgraduate (Ph. D.).....	Agr. for women (2 yrs.), dairying, hort. (winter, 10 weeks), bee culture (2 weeks).
Civil engin., mech. engin., mining engin. and metal., archi., chem., elect. engin., biol., phys., general studies, chem. engin., sanitary engin., geol., naval archi. (B. S.).	

tionments from the appropriation of 1890.

TABLE 1.—*Institutions established under the land-grant*

State or Territory.	Name of institution.	Location.	President.
Michigan.....	Michigan State Agricultural College.	Agricultural College.	J. L. Snyder, M. A., Ph. D....
Minnesota.....	The University of Minnesota...	Minneapolis.....	Cyrus Northrop, LL. D.....
Mississippi.....	Mississippi Agricultural and Mechanical College.	Agricultural College.	J. C. Hardy, M. A.....
Missouri.....	Alcorn Agricultural and Mechanical College.	Westside.....	W. H. Lanier.....
	University of Missouri.....	Columbia.....	R. H. Jesse, LL. D.....
	Lincoln Institute.....	Jefferson City.....	B. F. Allen, M. A.....
Montana.....	The Montana College of Agriculture and Mechanic Arts.	Bozeman.....	James Reid, B. A.....
Nebraska.....	The University of Nebraska...	Lincoln.....	E. B. Andrews, LL. D.....
Nevada.....	Nevada State University.....	Reno.....	J. E. Stubbs, M. A., D. D.....
New Hampshire...	The New Hampshire College of Agriculture and the Mechanic Arts.	Durham.....	W. D. Gibbs, M. S.....
New Jersey.....	Rutgers Scientific School, the New Jersey State College for the Benefit of Agriculture and the Mechanic Arts.	New Brunswick..	Austin Scott, Ph. D., LL. D.,
New Mexico.....	New Mexico College of Agriculture and Mechanic Arts.	Mesilla Park.....	Luther Foster, M. S. A.....
New York.....	Cornell University.....	Ithaca.....	J. G. Schurman, M. A., D. S., LL. D.
North Carolina...	The North Carolina College of Agriculture and Mechanic Arts.	West Raleigh.....	G. T. Winston, M. A., LL. D.,
	The Agricultural and Mechanical College for the Colored Race.	Greensboro.....	J. B. Dudley, M. A.....
North Dakota.....	North Dakota Agricultural College.	Agricultural College.	J. H. Worst, LL. D.....
Ohio.....	Ohio State University.....	Columbus.....	W. O. Thompson, D. D., LL. D.
Oklahoma.....	Oklahoma Agricultural and Mechanical College.	Stillwater.....	A. C. Scott, M. A., LL. M.....
	Agricultural and Normal University.	Langston.....	I. E. Page, M. A.....
Oregon.....	Oregon State Agricultural College.	Corvallis.....	T. M. Gatch, M. A., Ph. D....
Pennsylvania.....	The Pennsylvania State College	State College.....	G. W. Atherton, LL. D.....
Rhode Island.....	Rhode Island College of Agriculture and Mechanic Arts.	Kingston.....	K. L. Butterfield, M. A.....
South Carolina.....	Clemson Agricultural College of South Carolina.	Clemson College..	P. H. Meli, M. E., Ph. D.....
	The Colored Normal, Industrial, Agricultural, and Mechanical College of South Carolina.	Orangeburg.....	T. E. Miller, LL. D.....
South Dakota.....	South Dakota Agricultural College.	Brookings.....	James Chalmers, Ph. D.....

act of July 2, 1862, and their courses of study—Continued.

Collegiate courses of study (undergraduate).	
Four-year courses and degrees.	Short courses.
Agr., mech., for., women's (B. S., each 4 and 5 years).	Cheese making (4 weeks), creamery management, live stock and general farming (12 weeks), fruit culture (6 weeks), beet-sugar production (20 weeks).
Clas. (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), mining, metal. (E. M., M. E.), chem. (B. S.), agr. (B. Agr.).	Agr. (3 yrs.), agr. (8 weeks), dairying (4 weeks), phar.
Agr., hort., dairying, vet. sci., chem., mech. engin., phys. and elect. engin., civil and rural engin., geol. and mining, textile (B. S.).	Agr., mech. arts, elect. engin., textile (2 yrs.), agr. (10 weeks).
Scientific (B. S.)	Business, carpentry, agr., shoemaking, black-smithing, painting.
Agr. (B. S.), civil engin. (B. S., C. E.), mech. engin., mining engin. (B. S., M. E.), elect. engin. (B. S., E. E.), sanitary engin., chem., metal., archi. (B. S.).	Agron., animal husb., dairying (8 weeks).
Collegiate (B. A.), normal	College prep. (3 yrs.), normal prep. (2 yrs.), carpentry, blacksmithing, mach. work (3 yrs.), sewing, cooking, laundering (3 yrs.).
General sci., home sci. (B. S.), agr. (B. S. Agr.), chem. (B. A. C.), mech. engin. (B. M. E.), elect. engin. (B. E. E.), civil engin. (B. C. E.), biol. (B. S.), art, music.	Agr., domestic sci. (3 yrs.), business (1 yr.), domestic sci. (1 yr.), agr. engin. (2 winter terms, 18 weeks each).
Clas., lit. (B. A.), general sci., agr., civil engin., elect. engin., steam engin., municipal engin., mech. engin. (B. S.).	Agr. (3 yrs.), agr. (1 yr.), mech. arts, domestic sci. (2 yrs.), dairying, agr. (9 weeks), summer session (6 weeks), judging (1 week).
Liberal arts (B. A.), mining and metal., agr., domestic sci., mech. engin., civil engin., general sci., commerce (B. S.), pedag.	Agr., dairying, bot., ent., bact., domestic sci., assaying (3 months).
Agr., mech. engin., elect., tech. chem., general (B. S.).	Agr. (2 yrs.), agr. (winter, 10 weeks), dairying (10 weeks).
Agr., civil engin. and mech., chem., elect., biol., ceramics (B. S.), Lat. sci. (B. Litt.).	
Agr., mech. engin., domestic sci., general sci. (B. S.).	Agr. (2 yrs.), pract. mech. (2 yrs.), agr. and hort. (12 weeks).
Arts (B. A.), civil engin. (C. E.), mech. engin. (M. E.), elect. engin. (E. E.), archi. (B. Arch.), agr., (B. S. Agr.), for. (B. S. F.), med. (M. D.), vet. sci. (D. V. M.).	Agr. (1 or 2 yrs.), agr., dairying (winter, 11 weeks).
Agr. (B. A.), mech. engin., civil engin., elect. engin., indus. chem., mining engin., textile sci. and art. (B. E.).	Agr., mech. arts, building and contracting, textile indus. (2 yrs.), agr., dairying, road building (3 months), normal (1 and 2 yrs.), summer school for teachers (1 month).
Agr., mech. (B. S., B. Agr.)	Dairying (6 weeks).
Agr., sci., mech. (B. S.)	Agr. (3 yrs.), steam engin., dairying, phar., domestic econ., nature study (2 yrs.), agr. (10 weeks), stock and grain judging (10 days).
Agr. (B. S. Agr.), hort. and for., domestic sci., sci., chem., indus. arts, manual training, phar. (B. S.), arts (B. A.), Lat. philos., modern lang., philos., Engl. philos. (Ph. B.), archi., civil engin. (C. E.), clay working and ceramics, mech. engin., mining engin. (M. E.), elect. engin. (M. E., E. E.), vet. med. (D. V. M.), law (L. B.).	Agr., hort., ceramics, domestic econ., indus. arts, mining, phar. (2 yrs.), law, journalism (3 yrs.), dairying (3 months), vet. med. (3 yrs., D. V. M.).
Agr., general sci. and lit., mech. engin. (5 yrs. B. S.).	Agr., domestic sci. (2 yrs.), business (1 yr.), agr., hort., mech. arts (winter, 8 weeks).
Clas. (B. A.), sci. (B. S.), normal (B. S. D.), agr. (B. S. Agr.), elect. engin., mech. engin., civil arch. (B. M. E.).	Normal elementary (1 yrs.), college prep. (3 yrs.).
Agr., mech. engin., elect. engin., mining engin., household sci., phar., lit., commerce (B. S.).	Mining (2 yrs.), dairying (8 weeks), agr. (10 days).
Clas. (B. A.), general sci., Lat. sci., philos., agr., biol., chem., civil engin., elect. engin., indus. chem., math., mech. engin., mining engin., phys. (B. S.).	Chem., mech., mining (2 yrs.), agr. (1 yr.), agr., mining (12 weeks), creamery (8 weeks).
Agr., mech. engin., chem., biol., elect. engin., general sci. (B. S.).	Agr. (2 yrs.), farm mech. (12 weeks), poultry school (6 weeks), farm practice (6 weeks).
Agr., mech. and elect. engin., civil engin., metal., textile engin. (B. S.).	Textile indus. (2 yrs.).
Regular (B. A.), mech. (B. S.), agr. (B. Agr.), normal (L. I.).	
Agr., domestic sci., mech. engin., elect. engin., hort., phar. (B. S.).	Phar. (2 yrs.) (Ph. G.), agr. (6 weeks), hort., domestic sci., butter making, cheese making (12 weeks), sten. and typewriting, commercial sci., steam engin. (1 yr.), art (3 yrs.), music.

TABLE 1.—*Institutions established under the land-grant*

State or Territory.	Name of Institution.	Location.	President.
Tennessee	University of Tennessee	Knoxville	C. W. Dabney, Ph. D., LL. D.
Texas	Agricultural and Mechanical College of Texas.	College Station ...	D. F. Houston, M. A., LL. D.
	Prairie View State Normal and Industrial College.	Prairieview	E. L. Blackshear
Utah	Agricultural College of Utah ..	Logan	W. J. Kerr, D. Sc
Vermont	University of Vermont and State Agricultural College.	Burlington	M. H. Buckham
Virginia	The Virginia Agricultural and Mechanical College.	Blacksburg	J. M. McBryde, Ph. D., LL. D.
	Hampton Normal and Agricultural Institute.	Hampton	H. B. Frissell, D. D., LL. D.
Washington	Washington Agricultural College and School of Science.	Pullman	E. A. Bryan, M. A
West Virginia	West Virginia University	Morgantown	D. B. Purinton, Ph. D., LL. D.
Wisconsin	The West Virginia Colored Institute.	Institute	J. McH. Jones
	University of Wisconsin	Madison	C. R. Van Hise, Ph. D
Wyoming	University of Wyoming	Laramie	C. W. Lewis, M. S., D. D.

act of July 2, 1862, and their courses of study—Continued.

Collegiate courses of study (undergraduate).	
Four-year courses and degrees.	Short courses.
Lit. (B. A.), agr. sci., civil engin., mech. engin., elect. engin., chem. (B. S.), phar. (Ph. C.).	Agr., phar. (2 yrs.), agr., hort. (10 weeks), cereal judging, pract. stock feeding, stock judging and dairying, farm poultry (winter, 1 and 2 weeks). Stock farming, dairying, hort. (10 weeks).
Agr., textile engin., elect. engin., mech. engin., civil engin. (B. S.).	
Clas. and sci. (6 yrs.) (B. A.), normal, industrial..	
Agr., domestic sci., commercial, civil engin., mech. engin., elect. engin., general sci. (B. S.), mech. arts.	Agr., domestic sci., commercial (3 yrs.), prep. (2 yrs.), prep. (1 yr.), agr. (4 weeks), domestic arts, mech. arts (12 weeks).
Clas. (B. A.), lit. sci. (Ph. B.), civil and sanitary engin., elect. engin., mech. engin., chem., agr. (B. S.), commerce and econ. (B. A. or Ph. B.).	Agr. (1 or 2 yrs.).
Agr., hort., applied chem., general sci., civil engin., mech. engin., elect. engin. (B. S.), prep. med.	Agr., mech. (2 yrs.).
Math., civil engin., chem., bot. and zool., agr., hort., econ. sci. and hist., elect. engin., steam engin., hydraulic engin., mech. engin., mining engin. (B. S., B. A.), Engl. lang. and lit., modern lang. (B. A.).	Academic, trade (3 yrs.). Postgraduate: Agr., trades (3 yrs.), normal (2 yrs.), business (1 yr.). Supplementary courses in phys., geol. and mineralogy, Lat., schools of phar. (2 yrs.); agr., vet. sci., prep. (3 yrs.); business (1 and 2 yrs.); artisans (1 yr.); dairying (8 weeks); hort. (4 weeks).
General culture (B. A., B. S.), mech. engin. (B. S., M. E.), civil engin. (B. S., C. E.), steam engin., hydraulic engin., elect. engin. (B. S., M. E.), agr. (B. S. Agr.), law (LL. B.).	Agr. (B. Agr.), mech. and elect., law, commercial (2 yrs.), agr. (1 yr.), agr., hort., vet. sci., stock breeding and feeding, dairying, poultry culture (12 weeks), agr. (6 weeks).
Academic, normal, agr., mech., printing.....	Sewing (2 yrs.), dressmaking (3 yrs.).
Ancient clas. (B. A.), modern clas., civic hist., Engl. (B. L.), general sci. (B. S.), civil engin. (B. S., C. E.), mech. engin. (B. S., M. E.), elect. engin. (B. S., E. E.), agr. (B. S. Agr.), phar. (B. S. Ph.), sanitary engin., applied electro-chem.	Music, agr. (2 winter courses, 14 weeks each) dairy school (12 weeks), creamery (summer).
Clas., lit. sci. (B. A.), normal (B. Ped.), agr., mech. engin., mining engin. (B. S.).	Commercial (2 yrs.), agr. (1 to 2 yrs.), normal (1 yr.), school of mines (6 weeks), animal husb. (winter), domestic sci.

TABLE 2.—General statistics

State or Territory.	Date of establishment of institution.	Date of establishment of agricultural course.	Faculty.			Other departments.	Experiment station officers.
			College of agriculture and mechanic arts.		Total.		
			Preparatory classes.	Collegiate and special classes.			
Alabama (Auburn)	1872	1872	4	29	a 30	3	1
Alabama (Normal)	1875	1882	22	21	43		
Arizona	1891	1891	15	13	a 19		6
Arkansas (Fayetteville)	1872	1872	8	10	18	23	5
Arkansas (Pine Bluff)	1875		3	5	8		
California	1868	1868		66	66	163	30
Colorado	1877	1878	8	38	a 38		16
Connecticut	1881	1881		20	20		14
Delaware (Newark)	1870	1870		20	20		6
Delaware (Dover)	1892	1892	3	4	a 6		
Florida (Lake City)	1884	1884	6	18	a 21	4	14
Florida (Tallahassee)	1887	1890	11		11	7	
Georgia (Athens)	1872	1872		22	22		
Georgia (College)	1890	1890	10	4	14		8
Idaho	1892	1892	4	15	19	6	
Illinois	1867	1868		94	94	222	28
Indiana	1874	1874		86	86	4	10
Iowa	1869	1869			84		22
Kansas	1863	1874	6	49	a 52	11	18
Kentucky (Lexington)	1865	1880	4	22	26	12	18
Kentucky (Frankfort)	1887	1892	3	3	a 4	6	
Louisiana (Baton Rouge)	1877	1887	7	24	a 27		23
Louisiana (New Orleans)	1880	1890	8	8	16		
Maine	1865	1868		55	55		12
Maryland (College Park)	1859	1859	2	17	19	19	14
Maryland (Princess Anne)			10		10		
Massachusetts (Amherst)	1867	1867		23	23	3	24
Massachusetts (Boston)	1865			165	165		
Michigan	1855	1855	20	57	a 57		15
Minnesota	1869	1869		c 91	91	204	15
Mississippi (Agricultural College)	1880	1880	6	25	a 29	12	12
Mississippi (Westside)	1871	1878	13	6	19		
Missouri (Columbia)	1870	1870		67	d 67	40	20
Missouri (Jefferson City)	1866	1866	6	3	a 8	14	
Montana	1893	1893	2	26	28		9
Nebraska	1869	1869		43	43	157	18
Nevada	1873	1888	11	18	a 24		10
New Hampshire	1866	1866		21	21		12
New Jersey	1864	1865	11	28	39	3	7
New Mexico	1889	1890	4	24	28		11
New York	1865	1865					24
North Carolina (West Raleigh)	1889	1889		32	32		13
North Carolina (Greensboro)	1891	1891		14	14		
North Dakota	1890	1890	12	25	a 33		12
Ohio	1870	1873		105	105	32	
Oklahoma (Stillwater)	1891	1892	2	23	25		11
Oklahoma (Langston)	1897	1899	11		11		
Oregon	1868	1888		30	30		13
Pennsylvania	1855	1859	6	52	a 52		15
Rhode Island	1888	1890	7	25	a 25		11
South Carolina (Clemson College)	1889	1893	2	42	44		15
South Carolina (Orangeburg)	1896	1896	10	5	15	8	
South Dakota	1881	1884	1	36	37		19
Tennessee	1794	1869		47	47	45	12
Texas (College Station)	1871	1871		30	30		13
Texas (Prairieview)			6		6	11	
Utah	1888	1889			47		15
Vermont	1865	1885		38	38	32	12
Virginia (Blacksburg)	1872	1872		47	47		13
Virginia (Hampton)	1865	1890	99		99		
Washington	1892	1892	16	38	a 48		12
West Virginia (Morgantown)	1867	1867	7	60	67		13
West Virginia (Institute)	1891	1892	4	12	16		
Wisconsin	1848	1866	38	106	106	94	20
Wyoming	1887	1891	17	17	a 17	6	10
Total			445	2,024	2,461	1,141	662

a Total, counting none twice.

b Including all departments of the university.

of land-grant colleges, 1903.

Graduates.			Number of volumes in library.	Number of acres allotted to State under act of 1862.	Number of acres of land grant of 1862 still unsold.	Number of acres in farm and grounds.	Rate of in- terest on land grant fund of 1862.
In 1902-3.		Total num- ber since organiza- tion.					
Number.	Average age.						
	<i>Y. M.</i>						<i>Per cent.</i>
43	20 7	727	19,427	240,000	.....	325	.....
74	20 0	746	4,735	.....	.....	182	.....
7	27 0	35	19,502	.....	.....	465	.....
28	22 7	326	9,000	150,000	.....	155	8
5	21 0	160	4,736	.....	.....	20	.....
489	23 6	b3,319	108,418	150,000	4,195	411	6
21	.....	233	19,253	90,000	44,685	600	6
5	19 9	212	10,625	180,000	.....	300	5
22	22 0	321	22,800	90,000	.....	16	6
4	22 0	22	8,000	.....	.....	97	.....
8	21 11	83	4,000	90,000	.....	333	6
14	21 0	49	8,000	.....	.....	160	.....
15	21 2	386	43,050	270,000	.....	125	7
24	22 0	125	7,000	.....	.....	86	.....
30	23 6	98	6,600	90,000	90,000	130	.....
511	23 6	b3,401	90,000	480,000	40	665	5
185	23 2	1,762	15,400	390,000	.....	189	5
.....	.....	.....	20,000	204,000	1,016	841	6, 7, 8
53	22 7	918	27,710	82,313	.....	323	5, 5½, 6, 7
46	18 0	336	17,292	330,000	.....	258	6
15	23 0	115	1,769	.....	.....	310	.....
27	21 6	320	23,000	210,000	.....	583	4, 5
30	17 2	245	3,993	.....	.....	104	.....
47	23 2	815	25,000	210,000	.....	373	5
10	21 0	.....	6,750	210,000	.....	286	5, 6
.....	.....	9	600	.....	.....	120	.....
25	.....	611	25,258	360,000	.....	404	5
191	23 4	2,892	77,283	.....	.....	16	.....
60	23 8	971	24,003	235,682	61,553	684	7
386	.....	b4,513	113,000	94,000	40	300	3, 4, 5
23	.....	326	19,119	207,920	.....	2,000	6
7	25 0	140	2,700	.....	.....	300	5
126	.....	2,252	95,000	277,016	47,107	694	5
28	19 0	220	7,000	.....	.....	40	.....
12	21 0	35	11,000	90,000	90,000	215	.....
170	23 0	b2,045	59,550	90,000	30,000	332	4½, 6
28	21 0	220	9,000	90,000	.....	85	4
14	23 0	252	15,287	150,000	.....	343	6
41	22 2	489	50,655	210,000	.....	105	5
4	21 6	41	16,500	.....	.....	270	.....
510	.....	b7,030	317,899	989,920	.....	498	5
36	22 2	211	6,000	270,000	.....	593	6
11	23 0	35	9,929	.....	.....	125	.....
2	21 6	33	9,350	130,000	99,650	640	.....
155	22 0	1,536	53,223	630,000	.....	345	6
23	21 6	76	23,466	.....	.....	360	.....
2	20 0	2	750	.....	.....	160	.....
29	20 0	466	3,300	90,000	.....	199	6
72	23 8	654	20,000	780,000	.....	400	6
6	22 0	101	15,200	120,000	.....	178	3
60	19 0	258	10,417	.....	.....	1,136	6
59	20 0	233	1,390	.....	.....	130	.....
17	22 0	232	17,350	160,000	159,628	400	.....
56	22 10	.....	25,600	300,000	.....	272	6
36	21 0	459	9,000	180,000	.....	2,416	6, 7
45	22 0	306	1,109	.....	.....	1,500	.....
10	22 0	98	23,500	200,000	200,000	116	.....
45	23 0	3,681	98,345	150,000	.....	120	6
55	18 0	435	5,000	220,000	.....	410	6
84	22 4	1,236	12,698	110,000	.....	798	.....
27	25 0	125	9,385	90,000	90,000	250	.....
50	23 0	881	20,400	150,000	.....	130	6
20	20 0	103	2,800	.....	.....	68	.....
281	21 0	b5,189	101,086	240,000	80	400	4
5	23 0	102	24,249	90,000	90,000	416	.....
4,524	21 10	53,252	1,837,461	10,170,851	1,007,994	25,305	.....

c Including preparatory classes.

d Including School of Mines at Rolla.

TABLE 3.—Students by classes and

State or Territory.	By classes.					
	Prepara- tory classes.	Collegi- ate classes.	Short or special.	Post- gradu- ate.	Other depart- ments.	Total.
Alabama (Auburn).....	57	284	78	16		435
Alabama (Normal).....	378	9	81			468
Arizona.....	122	72		4		198
Arkansas (Fayetteville).....	367	186	56	2	473	1,084
Arkansas (Pine Bluff).....	82	98				180
California.....		902	45	40	1,682	2,669
Colorado.....	241	181	65	6		493
Connecticut.....		80	48			b 127
Delaware (Newark).....		111	1	2		114
Delaware (Dover).....	34	19	2			55
Florida (Lake City).....	111	81	9	1		b 179
Florida (Tallahassee).....	167				4	171
Georgia (Athens).....		149	19			168
Georgia (College).....	405	32	2			439
Idaho.....	162	79	63		49	353
Illinois.....		753	138	27	2,370	3,288
Indiana.....		1,109	176	54		1,339
Iowa.....	230	901	346	6	113	1,596
Kansas.....	342	927	338	24		b 1,574
Kentucky (Lexington).....	108	482		12	94	696
Kentucky (Frankfort).....	35	19		2	144	200
Louisiana (Baton Rouge).....	137	273	4	10		424
Louisiana (New Orleans).....	377		325			b 377
Maine.....		339	69	9		417
Maryland (College Park).....	25	160	15			200
Maryland (Princess Anne).....	140					140
Massachusetts (Amherst).....		149	28	7		184
Massachusetts (Boston).....		1,591		17		1,608
Michigan.....	196	423	234	9		854
Minnesota.....	471	533	139	4	2,641	b 3,677
Mississippi (Agricultural College).....	241	372	32	3		648
Mississippi (Westside).....	479	55				534
Missouri (Columbia).....		c 533	c 32	c 29	c 848	c 1,442
Missouri (Jefferson City).....	84	1	22	3	276	386
Montana.....	98	53	39	10	105	305
Nebraska.....	224	403	46		1,887	2,560
Nevada.....	106	211				317
New Hampshire.....		98	22	1		121
New Jersey.....	155	156	1	4	62	378
New Mexico.....	109	31	82			222
New York.....		1,367	805	201	1,382	3,457
North Carolina (West Raleigh).....		497		8		505
North Carolina (Greensboro).....		166	1			167
North Dakota.....	80	32	587	1		700
Ohio.....		808	97		812	1,717
Oklahoma (Stillwater).....	175	150	112	3	435	875
Oklahoma (Langston).....	237					237
Oregon.....	54	405	70	12		541
Pennsylvania.....	53	502	d 1,845	2		2,402
Rhode Island.....	44	36	22			102
South Carolina (Clemson College).....	102	406	26	5		539
South Carolina (Orangeburg).....	601	64				665
South Dakota.....	154	139	191	3		487
Tennessee.....		320	60	5	372	757
Texas (College Station).....		364	28	4		396
Texas (Prairieview).....	276					276
Utah.....	68	59	413	5		545
Vermont.....		306	53	1	234	594
Virginia (Blacksburg).....		539	64	24		627
Virginia (Hampton).....	888	269	h 455	23		1,635
Washington.....	231	188	163		29	b 595
West Virginia (Morgantown).....		64	3	1	771	839
West Virginia (Institute).....	144		6			150
Wisconsin.....		614	441	7	1,808	2,870
Wyoming.....	11	11			169	191
Total.....	8,801	19,161	7,999	607	16,760	52,489

a Including electrical engineering.

b Total, counting none twice.

c Including school of mines at Rolla.

d Including 1,800 enrolled in correspondence courses.

courses at land-grant colleges in 1903.

By courses.														
Four-year.									Shorter.					
Agriculture.	Horticulture.	Household economy.	Mechanical engineering.	Civil engineering.	Electrical engineering.	Mining engineering.	Chemical engineering.	Architecture.	Agriculture.	Dairying.	Horticulture.	Veterinary science.	Military tactics.	
24	10		48	39	52				8			20	391	
106		30	8	6		30	2						222	
11	13		11	46	34								100	
													509	
91		50	a 235	134		277			45				883	
22	22	92	41	43				9	10	11		10	316	
50		13							5	5	1		53	
4			8	33	23				4				85	
2									2					
36	10		51	25									125	
15									15				73	
5	5			15	10				19	19	19		168	
									40				227	
	1			11	8	31							133	
138		26	182	192	137		7	83	128	14	29	66	675	
42			353	266	371				72				685	
255		75	105	140	162	19			346	92		48	500	
219		237	a 253						123	38	123		500	
10			a 155	54		4			3				483	
									29				89	
44		57	38	45			22							
									46					
4			32	110	99	2			21	21			200	
1			72						15	3	15		185	
56													60	
143	143								28	38	28	9	178	
			133	129	118	83	30	43					400	
127		83	214						148				480	
18	18		83	104	132	111	21		57	82			850	
201	201		44	4								201	642	
158									158					
95		28	33	100	78	209	2		67	35		60	162	
									80					
1			10	8					21	4			125	
160	17	78	386	153	86				46	46	46	8	404	
			18	2		63							160	
26			26		11		8		10	8			98	
13				56	37		22						153	
5		6	9						3				135	
60			886	252			47		121			62		
45			63	56	79	1	17		56	30			445	
30														
2			6						396	76	26	92	76	
77	10		80	83	86	35	21		58	41		87	933	
17			36						24					
53														
70		76	110		11	19				20				
14			112	106	150	34			e 1,802	32			475	
3			2		7				22				40	
205			a 142	13									533	
116									116				300	
15	2		25		25				3	11			99	
67	f 60	17	20	72	9				37	37	37	37	170	
150			g 194						22			61	396	
									26					
6		5	3	17	3	1			43	3	5		213	
40	18		16	29	33		36		4	53	18	24	125	
50	6		121	77	199							20	590	
									911				404	
6	3		16	17	14	22				6	20	6	200	
2			35	24					3				144	
									12				69	
32			63	124	134				300	142			499	
4			7			14							156	
3,146	539	873	4,475	2,587	2,116	955	188	182	5,505	867	367	811	16,316	

e Including correspondence courses.

f Including forestry.

g Including civil engineering.

h Summer institute.

TABLE 4.—*Value of permanent funds*

State or Territory.	Land-grant fund of 1862.	Other land-grant funds.	Other permanent funds.	Land grant of 1862 still unsold.	Farm and grounds owned by the institution.
Alabama (Anburn).....	\$253,500.00				\$4,500.00
Alabama (Normal).....					18,200.00
Arizona.....					25,640.00
Arkansas (Fayetteville).....	130,000.00				10,000.00
Arkansas (Pine Bluff).....					50,000.00
California.....	730,965.54	\$74,962.27	\$2,251,572.23	\$10,486.18	215,000.00
Colorado.....	90,144.85			150,000.00	48,000.00
Connecticut.....	135,000.00				15,000.00
Delaware (Newark).....	83,000.00				5,000.00
Delaware (Dover).....					6,000.00
Florida (Lake City).....	154,300.00				18,800.00
Florida (Tallahassee).....					5,500.00
Georgia (Athens).....	243,000.00				15,000.00
Georgia (College).....					10,000.00
Idaho.....		112,590.16		900,000.00	15,000.00
Illinois.....	613,026.53			400.00	150,000.00
Indiana.....	340,000.00				100,000.00
Iowa.....	589,754.01	93,954.51		4,734.08	60,000.00
Kansas.....	492,381.36				39,700.00
Kentucky (Lexington).....	165,000.00				357,000.00
Kentucky (Frankfort).....			6,625.00		22,600.00
Louisiana (Baton Rouge).....	182,313.00	136,000.00			35,000.00
Louisiana (New Orleans).....					22,500.00
Maine.....	118,300.00		101,600.00		25,000.00
Maryland (College Park).....	118,000.00				28,600.00
Maryland (Princess Anne).....					6,000.00
Massachusetts (Amherst).....	219,000.00		141,575.35		42,000.00
Massachusetts (Boston).....			3,537,709.81		
Michigan.....	915,454.43			200,000.00	48,107.50
Minnesota.....	570,335.59	763,699.96		240.00	550,000.00
Mississippi (Agricultural College).....	98,575.00	141,212.55			43,500.00
Mississippi (Westside).....	113,575.00	96,296.00			6,000.00
Missouri (Columbia).....	349,881.19			60,000.00	237,206.00
Missouri (Jefferson City).....					6,000.00
Montana.....	12,500.00	5,000.00		180,000.00	12,000.00
Nebraska.....	228,000.00	105,000.00			325,000.00
Nevada.....	93,000.00				35,000.00
New Hampshire.....	80,000.00		70,000.00		20,500.00
New Jersey.....	116,000.00		500,000.00		130,000.00
New Mexico.....					8,500.00
New York.....	688,576.12		6,783,886.28		369,077.98
North Carolina (Raleigh).....	125,000.00				26,189.55
North Carolina (Greensboro).....					18,000.00
North Dakota.....	62,981.80			996,500.00	32,000.00
Ohio.....	524,146.30	44,730.18			1,500,000.00
Oklahoma (Stillwater).....					15,000.00
Oklahoma (Langston).....					5,000.00
Oregon.....	131,556.37				25,000.00
Pennsylvania.....	427,290.50				40,000.00
Rhode Island.....	50,000.00				18,000.00
South Carolina (Clemson College).....	95,900.00				26,730.00
South Carolina (Orangeburg).....	95,900.00				40,000.00
South Dakota.....	4,585.07			800,000.00	40,000.00
Tennessee.....	400,000.00				116,370.00
Texas (College Station).....	209,000.00				48,320.00
Texas (Prairieview).....					15,000.00
Utah.....		43,516.20			12,800.00
Vermont.....	135,500.00		399,584.19		25,000.00
Virginia (Blacksburg).....	344,312.00				31,000.00
Virginia (Hampton).....	172,156.00		1,132,594.63		57,000.00
Washington.....		1,000,000.00		900,000.00	20,000.00
West Virginia (Morgantown).....	114,169.67		1,600.00		225,000.00
West Virginia (Institute).....					12,000.00
Wisconsin.....	303,359.61	228,263.95		100.00	110,500.00
Wyoming.....	21,450.57	4,067.71		90,000.00	10,600.00
Total.....	11,140,890.51	2,849,293.49	14,926,747.49	4,292,460.26	5,610,441.03

^aIncluding all other equipment.^bIncluding machinery.

and equipment of land-grant colleges, 1903.

Buildings.	Apparatus.	Machinery.	Library.	Live stock.	Miscellaneous equipment.	Total.
\$143,000.00	\$14,000.00	\$18,000.00	\$34,000.00	\$2,500.00	\$17,000.00	\$486,500.00
45,353.54	4,001.58	4,992.30	2,957.00	400.00	532.09	76,436.51
120,008.89	18,757.62	13,412.17	13,905.49	1,700.00	-----	193,424.17
300,000.00	50,000.00	20,000.00	7,000.00	1,250.00	-----	518,250.00
26,000.00	500.00	12,000.00	3,000.00	-----	1,500.00	93,000.00
785,000.00	-----	-----	-----	-----	a 410,000.00	4,477,986.22
163,849.00	46,000.00	17,000.00	15,002.59	12,940.00	16,500.00	559,436.44
112,000.00	8,300.00	3,391.00	21,000.00	5,455.00	17,400.00	317,546.00
125,000.00	51,000.00	5,400.00	21,000.00	250.00	8,000.00	298,650.00
18,800.00	1,000.00	8,000.00	-----	-----	33,800.00	33,800.00
120,000.00	-----	-----	-----	-----	a 46,650.00	339,750.00
20,000.00	6,944.55	1,650.00	1,000.00	1,410.00	3,000.00	39,504.55
340,000.00	50,000.00	10,000.00	52,000.00	750.00	390,000.00	1,100,750.00
32,433.01	3,144.00	100.00	100.00	415.00	-----	46,092.04
175,200.00	20,000.00	3,600.00	11,500.00	1,600.00	3,000.00	1,242,490.16
1,200,000.00	165,000.00	65,000.00	90,000.00	10,000.00	114,000.00	2,407,426.53
458,900.00	b 158,350.00	-----	18,500.00	3,500.00	20,000.00	1,099,250.00
540,000.00	75,000.00	32,000.00	30,500.00	22,948.00	115,000.00	1,563,890.60
349,098.05	47,563.54	15,952.93	57,494.82	16,711.00	78,130.83	1,097,032.53
197,276.00	46,812.00	25,274.00	11,216.00	2,557.00	420,307.00	1,225,442.00
23,000.00	400.00	2,500.00	1,800.00	-----	1,200.00	58,125.00
250,000.00	15,680.82	11,507.21	25,849.65	-----	26,000.00	682,550.68
47,760.82	3,496.78	4,415.10	3,980.00	1,100.00	7,200.00	90,452.70
225,000.00	23,345.00	16,000.00	27,081.61	4,000.00	12,500.00	552,826.61
90,000.00	-----	-----	-----	-----	a 35,000.00	271,600.00
16,000.00	1,400.00	1,300.00	400.00	1,250.00	2,000.00	28,550.00
248,775.00	19,704.03	-----	25,258.00	9,500.00	95,531.59	801,343.97
786,713.86	250,000.00	91,140.00	128,507.00	-----	50,000.00	4,844,100.67
409,645.00	4,000.00	16,700.00	43,859.38	-----	97,457.29	1,735,223.60
1,143,000.00	98,000.00	80,000.00	90,000.00	12,600.00	-----	3,307,875.55
243,945.00	20,021.20	99,132.91	17,648.83	16,015.00	54,198.57	734,249.09
150,000.00	10,000.00	-----	3,000.00	2,000.00	2,000.00	382,871.00
300,000.00	-----	-----	-----	-----	a 135,000.00	1,082,087.19
100,000.00	400.00	5,000.00	300.00	150.00	50.00	111,900.00
110,000.00	15,000.00	15,000.00	15,000.00	1,000.00	10,000.00	375,500.00
169,000.00	96,500.00	-----	125,000.00	13,500.00	100,000.00	1,462,000.00
164,936.69	19,285.09	11,669.45	18,540.96	642.10	37,344.93	380,419.22
200,000.00	20,000.00	6,000.00	10,600.00	3,000.00	15,000.00	425,100.00
40,000.00	-----	-----	45,000.00	-----	75,000.00	1,266,000.00
45,000.00	17,000.00	20,000.00	13,000.00	1,200.00	6,500.00	111,200.00
2,480,153.74	-----	-----	545,572.00	-----	857,717.95	11,724,984.07
156,917.00	13,822.08	36,374.38	6,232.20	3,430.00	15,000.00	382,965.21
60,000.00	4,000.00	6,000.00	1,150.00	972.50	-----	90,122.50
154,000.00	13,622.72	10,526.66	16,327.55	4,970.00	-----	1,290,928.73
1,000,000.00	200,000.00	100,000.00	130,000.00	5,000.00	10,000.00	3,513,876.48
98,500.00	36,484.63	23,028.82	18,994.76	8,000.00	-----	200,008.22
33,901.35	1,500.00	8,569.25	1,600.00	525.00	2,044.25	53,142.85
160,000.00	3,500.00	17,500.00	-----	-----	-----	337,556.37
850,000.00	-----	-----	-----	-----	60,000.00	1,377,290.50
200,000.00	-----	-----	15,175.68	-----	a 101,660.86	384,836.54
343,152.00	90,000.00	68,668.00	8,000.00	5,300.00	15,000.00	652,750.00
8,500.00	3,600.00	7,150.00	1,700.00	2,200.00	2,000.00	161,050.00
170,000.00	12,000.00	3,700.00	5,300.00	9,100.00	7,000.00	1,051,685.07
206,179.98	49,582.18	46,611.36	11,825.27	3,450.00	13,191.90	847,210.69
400,000.00	10,205.23	18,872.70	5,500.00	10,427.00	28,283.87	730,608.80
92,100.00	1,000.00	3,000.00	909.00	2,660.00	-----	114,669.00
221,337.92	10,386.43	10,225.00	7,287.81	5,645.00	23,928.64	335,127.00
689,200.00	51,000.00	10,000.00	100,000.00	4,110.00	75,000.00	1,489,394.19
217,410.00	b 123,775.80	-----	2,700.00	-----	-----	749,227.80
591,000.00	-----	-----	6,500.00	14,000.00	c 155,000.00	2,128,250.63
250,000.00	21,000.00	38,500.00	21,000.00	6,000.00	15,000.00	2,271,500.00
450,000.00	10,000.00	20,000.00	40,000.00	1,500.00	40,000.00	902,269.67
74,000.00	-----	18,771.00	2,000.00	500.00	1,500.00	108,771.00
1,440,030.00	b 283,437.00	-----	157,927.00	13,358.06	-----	2,536,995.62
175,000.00	60,220.00	29,271.00	24,100.00	1,000.00	7,300.00	423,009.28
21,216,159.88	2,379,742.28	1,112,805.28	2,114,802.60	252,490.66	3,852,629.77	69,778,463.25

c Including apparatus and machinery.

TABLE 5.—*Revenue of land-grant colleges*

State or Territory.	Federal aid.			State aid.
	Interest on land grant of 1862.	Interest on other land grants.	Appropriation act of 1890.	Interest on endowment or regular appropriation.
Alabama (Auburn).....	\$20,280.00		\$13,850.00	
Alabama (Normal).....			11,150.00	
Arizona.....			25,000.00	
Arkansas (Fayetteville).....			18,181.82	\$40,000.00
Arkansas (Pine Bluff).....			6,818.18	
California.....	43,870.00	\$4,440.00	25,000.00	67,679.61
Colorado.....	13,124.26		25,000.00	
Connecticut.....	6,400.00		25,000.00	
Delaware (Newark).....	4,980.00		20,000.00	
Delaware (Dover).....			5,000.00	
Florida (Lake City).....	8,961.23		12,500.00	
Florida (Tallahassee).....			12,500.00	
Georgia (Athens).....	16,954.14		16,666.67	
Georgia (College).....			8,333.33	
Idaho.....		275.00	25,000.00	
Illinois.....	31,984.40		25,000.00	
Indiana.....	17,000.00		25,000.00	
Iowa.....	36,728.57		25,000.00	
Kansas.....	24,050.62		25,000.00	
Kentucky (Lexington).....	8,644.50		21,375.00	34,335.04
Kentucky (Frankfort).....	1,255.50		3,625.00	
Louisiana (Baton Rouge).....	9,115.69	5,440.00	12,651.23	
Louisiana (New Orleans).....			12,348.77	
Maine.....	5,915.00		25,000.00	
Maryland (College Park).....	5,900.00		17,588.18	
Maryland (Princess Anne).....			7,411.82	
Massachusetts (Amherst).....	7,300.00		16,666.66	4,263.22
Massachusetts (Boston).....	5,501.68		8,333.34	
Michigan.....	65,573.90		25,000.00	
Minnesota.....	22,745.62		25,000.00	30,458.00
Mississippi (Agricultural College).....	5,914.50	8,358.00	11,562.50	
Mississippi (Westside).....	6,814.50	5,775.77	13,437.50	
Missouri (Columbia).....	17,494.10		23,437.50	6,599.53
Missouri (Jefferson City).....			1,562.50	
Montana.....	8,920.00		25,000.00	
Nebraska.....	35,000.00	20,000.00	25,000.00	82,500.00
Nevada.....			25,000.00	
New Hampshire.....	4,800.00		25,000.00	
New Jersey.....	5,800.00		25,000.00	
New Mexico.....			25,000.00	
New York.....	34,428.80		25,000.00	
North Carolina (West Raleigh).....	7,500.00		16,750.00	
North Carolina (Greensboro).....			8,250.00	
North Dakota.....	4,759.69		25,000.00	
Ohio.....	31,448.77	2,622.14	25,000.00	
Oklahoma (Stillwater).....		16,471.37	22,500.00	
Oklahoma (Langston).....			2,500.00	
Oregon.....	8,689.98		25,000.00	
Pennsylvania.....	25,637.43		25,000.00	5,382.57
Rhode Island.....	2,500.00		25,000.00	
South Carolina (Clemson College).....	5,754.00		12,500.00	
South Carolina (Orangeburg).....	5,754.00		12,500.00	
South Dakota.....		8,046.31	25,000.00	
Tennessee.....	23,960.00		25,000.00	
Texas (College Station).....	14,280.00		18,750.00	
Texas (Prairieview).....			6,250.00	
Utah.....	10,154.22		25,000.00	
Vermont.....	8,130.00		25,000.00	5,000.00
Virginia (Blacksburg).....	20,658.72		16,666.67	
Virginia (Hampton).....	10,329.36		8,333.33	
Washington.....			25,000.00	
West Virginia (Morgantown).....	6,553.00		20,000.00	
West Virginia (Institute).....			5,000.00	
Wisconsin.....	12,525.39	13,474.72	25,000.00	
Wyoming.....	83.20		25,000.00	2,191.28
Total.....	674,174.77	84,903.31	1,200,000.00	278,409.25

^a Including incidental fees.^b Amount expended from an annual appropriation of \$100,000.

for year ended June 30, 1903.

State aid.		Income from endowment other than Federal or State grants.	Fees and all other sources.			Total.	United States appropriation for experiment stations (act of 1887).
Appropriation for current expenses.	Appropriations for buildings or for other special purposes.		Tuition fees.	Incidental fees.	Miscellaneous.		
\$15,848.02	\$750.00	-----	\$930.00	\$1,997.50	\$1,679.27	\$55,334.79	\$15,000.00
4,000.00	-----	-----	-----	-----	-----	15,150.00	-----
17,113.85	-----	-----	-----	1,999.86	108.35	44,222.06	15,000.00
14,590.00	10,300.00	-----	-----	3,115.00	600.00	86,786.82	15,000.00
3,789.00	-----	-----	329.00	-----	-----	10,336.18	-----
359,000.00	-----	\$48,310.24	31,709.55	-----	58,317.48	638,326.88	15,000.00
59,592.89	40,000.00	-----	-----	-----	9,182.42	146,899.57	15,000.00
15,000.00	1,800.00	-----	-----	-----	25,000.00	73,200.00	7,500.00
-----	12,500.00	-----	12,050.00	3,479.94	512.18	53,522.12	15,000.00
-----	-----	-----	1,500.00	434.10	2,071.39	9,005.49	-----
-----	26,437.97	-----	-----	2,896.71	-----	50,795.91	15,000.00
2,000.00	200.00	-----	-----	-----	500.00	15,200.00	-----
-----	-----	-----	-----	814.75	353.48	34,789.04	15,000.00
8,000.00	-----	-----	-----	-----	-----	16,333.33	-----
21,500.00	50,000.00	-----	-----	214.00	1,408.61	98,397.61	15,000.00
175,000.00	108,000.00	-----	4181,487.46	-----	38,258.67	559,730.53	15,000.00
67,950.00	60,973.39	-----	4,475.00	34,394.50	9,817.06	219,609.95	15,000.00
60,000.00	141,262.31	-----	900.00	420.00	2,481.48	266,792.36	15,000.00
30,000.00	24,280.00	-----	-----	-----	-----	103,330.62	15,000.00
-----	30,000.00	-----	4,299.85	-----	1,172.41	99,826.80	15,000.00
8,000.00	-----	-----	-----	200.00	2,257.76	15,338.26	-----
15,000.00	83,682.00	-----	-----	2,112.50	5,890.90	138,892.32	15,000.00
10,000.00	-----	-----	168.00	76.50	851.35	23,444.62	-----
25,000.00	-----	4,000.00	12,000.00	9,185.17	-----	81,100.17	15,000.00
9,000.00	45,000.00	-----	19,998.68	-----	8,747.94	106,234.80	15,000.00
-----	-----	-----	103.50	415.00	1,361.53	9,291.85	-----
33,000.00	86,505.00	-----	-----	783.29	2,041.10	150,559.27	15,000.00
25,000.00	-----	65,000.00	252,987.75	11,794.01	34,520.48	403,137.26	-----
^b 60,000.00	44,000.00	-----	465.00	5,110.00	26,424.99	226,573.89	15,000.00
187,518.00	109,500.00	-----	104,915.30	5,037.95	16,161.36	501,336.23	15,000.00
48,272.41	-----	-----	460.00	1,725.00	25,939.99	102,232.40	15,000.00
8,000.00	3,000.00	-----	-----	1,068.00	700.00	38,795.77	-----
11,500.00	181,163.02	-----	-----	7,021.00	3,293.91	250,509.06	15,000.00
22,175.00	10,000.00	-----	-----	-----	-----	33,737.50	-----
15,000.00	3,500.00	-----	2,375.00	800.00	4,516.67	60,111.67	15,000.00
37,250.00	-----	-----	9,830.00	8,825.00	18,333.10	236,738.10	15,000.00
21,250.00	-----	-----	1,000.00	-----	-----	47,250.00	15,000.00
10,500.00	33,000.00	3,965.00	905.91	1,209.97	42,076.08	121,456.96	15,000.00
2,500.00	12,000.00	17,971.76	-----	^d 6,036.00	629.30	69,937.06	15,000.00
5,652.10	-----	-----	1,302.00	-----	4,034.12	35,988.22	15,000.00
-----	-----	390,796.56	223,145.32	57,058.76	306,141.08	1,036,570.52	13,500.00
10,000.00	48,000.00	-----	7,361.79	4,906.20	14,030.48	108,548.47	15,000.00
7,500.00	5,000.00	-----	-----	-----	22,938.78	43,688.78	-----
26,592.02	-----	-----	-----	131.50	4,612.74	61,095.95	15,000.00
229,463.11	113,203.46	-----	6,191.25	34,808.75	90,366.85	533,104.33	-----
6,603.03	-----	-----	-----	1,311.00	4,658.29	51,543.69	15,000.00
17,000.00	-----	-----	-----	-----	-----	19,500.00	-----
13,434.94	26,842.25	-----	-----	834.60	2,005.34	76,807.11	15,000.00
42,228.87	1,750.00	-----	540.00	9,048.38	19,638.84	129,226.09	15,000.00
15,000.00	3,000.00	-----	100.00	39.86	-----	45,639.86	15,000.00
85,200.00	-----	3,512.36	2,798.88	-----	4,397.18	114,162.42	15,000.00
-----	6,500.00	-----	-----	-----	-----	24,754.00	-----
26,500.00	-----	-----	2,282.00	3,033.50	9,875.58	74,737.39	15,000.00
-----	10,000.00	1,944.50	13,470.86	-----	14,340.93	88,716.29	15,000.00
25,000.00	10,000.00	-----	-----	-----	-----	68,030.00	15,000.00
20,500.00	-----	-----	-----	-----	12,241.26	38,991.26	-----
26,000.00	31,000.00	-----	2,786.00	1,146.25	8,174.19	104,260.66	15,000.00
6,000.00	-----	16,013.31	^a 18,914.47	-----	4,301.08	83,558.86	15,000.00
40,000.00	-----	50,606.88	1,245.00	20,393.95	1,267.32	100,231.66	15,000.00
-----	-----	-----	-----	-----	124,777.39	194,046.96	-----
55,000.00	12,500.00	-----	130.00	2,572.45	16,330.15	111,532.60	15,000.00
97,050.00	34,278.00	-----	-----	-----	13,559.50	171,440.50	14,999.50
1,600.00	22,000.00	-----	-----	116.00	809.95	29,525.95	-----
289,000.00	120,000.00	681.80	21,668.50	47,419.75	96,108.00	625,878.16	15,000.00
22,175.20	16,000.00	-----	-----	506.25	1,175.49	67,131.42	15,000.00
2,469,848.44	1,577,927.40	602,802.41	941,826.07	294,492.95	1,120,993.80	9,248,378.40	695,999.50

^c Including School of Mines at Rolla.^d Including tuition fees.

TABLE 6.—Additions to equipment of land-grant colleges, 1903.

State or Territory.	Permanent endowment.	Buildings.	Library.	Apparatus.	Machinery.	Live stock.	Miscellaneous.	Total.
Alabama (Anburn)			\$2,076.00	\$1,100.00	\$2,600.00	\$380.00	\$2,045.00	\$8,161.00
Alabama (Normal)		\$2,550.00		325.00	854.00		150.00	3,879.00
Arizona		6,575.00	1,632.48	1,662.48	629.61	750.00	926.79	12,176.36
Arkansas (Fayetteville)			1,000.00	15,000.00	5,000.00		5,000.00	26,000.00
Arkansas (Pine Bluff)								
California	\$22,472.08	45,000.00	20,000.00				a 15,000.00	102,472.08
Colorado		12,000.00			1,500.00	4,000.00	1,000.00	18,500.00
Connecticut		965.33	405.01	454.03		1,710.07	1,873.40	5,407.84
Delaware (Newark)			1,250.00	2,500.00	850.00		2,300.00	6,900.00
Delaware (Dover)			25.00					175.00
Florida (Lake City)		20,000.00	158.39	1,967.96	409.82	105.00	615.16	23,256.33
Florida (Tallahassee)		200.00	100.00	200.00	500.00	225.00		1,225.00
Georgia (Athens)		600.00	1,600.57	750.00	200.00	625.00	150.00	3,925.57
Georgia (College)			100.00			135.00		235.00
Idaho	75,306.78	205.69	938.38	3,818.63	379.32		500.00	81,268.80
Illinois	15,806.00		10,000.00	5,000.00	5,000.00	4,000.00	4,000.00	43,806.00
Indiana		107,633.61	540.00		b 8,150.00	1,000.00	8,135.00	125,458.61
Iowa		38,523.20	3,500.00	4,000.00	3,000.00		2,000.00	51,023.20
Kansas		10,000.00	1,500.00	2,000.00	2,000.00	5,000.00		23,500.00
Kentucky (Lexington)		36,276.55	616.00	3,412.00	1,074.00	2,557.00	3,307.00	47,242.55
Kentucky (Frankfort)			100.00	15.00		100.00		215.00
Louisiana (Baton Rouge)		42,200.31	849.65	2,680.82	2,507.21			48,237.99
Louisiana (New Orleans)		396.00	30.00	67.58	15.10	540.00	300.00	1,348.68
Maine		329.16	2,581.61	1,345.00				4,255.77
Maryland (College Park)		26,000.00	400.00	1,500.00			500.00	28,400.00
Maryland (Princess Anne)		5,999.50	395.63	1,346.05	1,241.70	769.50	1,072.62	10,855.06
Massachusetts (Amherst)		86,505.00	1,750.00	657.46				88,912.46
Massachusetts (Boston)			5,160.00		50,000.00			151,684.18
Michigan		30,000.00						30,000.00
Minnesota		72,500.00	7,500.00	12,000.00	1,000.00	4,000.00		97,000.00
Mississippi (Agricultural College)		65,037.00	2,005.46	5,074.08	20,098.28	2,920.00	8,355.02	103,570.84
Mississippi (Westside)		3,006.00				500.00		3,506.00
Missouri (Columbia)								
Missouri (Jefferson City)								
Montana		3,500.00	1,500.00	1,065.00	700.00	350.00	500.00	7,615.00
Nebraska			7,331.32		b 3,000.00	3,000.00	5,000.00	18,964.32
Nevada		723.44	235.88	821.39	183.89		1,967.74	4,132.54
New Hampshire		45,000.00	1,153.00	4,360.02		2,050.00		52,563.02
New Jersey		64,000.00	2,094.76	1,350.88			585.71	78,773.13
New Mexico	2,500.00	1,300.00	985.00	500.00	8,241.78	512.00	500.00	4,737.00
New York		9,249.79	17,187.60	500.00	1,000.00		a 115,385.09	306,317.26
North Carolina (West Raleigh)	224,494.78	43,131.29	400.00	2,000.00	1,500.00	1,200.00		48,231.29
North Carolina (Greensboro)				261.86		542.32	1,321.56	2,676.00
North Dakota		100.00	327.55	1,622.72	526.66	440.00	325.00	3,341.93

Ohio.....	6,206.54	100,000.00	7,000.00	5,000.00	3,000.00	2,000.00	9,000.00	132,206.54
Oklahoma (Stillwater).....		859.45	1,029.86	9,738.47	100.00	1,027.00	3,465.00	16,220.28
Oklahoma (Langston).....								69.25
Oregon.....		26,842.25	447.33	100.00	383.33	62.40		27,855.31
Pennsylvania.....		300,000.00						300,000.00
Rhode Island.....								2,096.78
South Carolina (Clemson College).....		14,250.33	1,496.78	600.00				19,690.12
South Carolina (Orangeburg).....			1,000.00	1,576.31			156.27	189.27
South Dakota.....		1,175.00	240.00	33.00	1,493.00	2,165.00	1,300.00	7,648.00
Tennessee.....		771.32	825.27	2,090.26	1,215.00	150.00	1,490.99	7,024.20
Texas (College Station).....					1,696.36			
Texas (Prairieview).....			350.00			1,000.00		1,350.00
Utah.....	43,516.20	15,845.21	739.46	458.36	608.62	1,040.01	4,113.46	66,321.32
Vermont.....	63,000.00	2,000.00	1,500.00	2,000.00				68,500.00
Virginia (Blacksburg).....		28,700.00	100.00				11,280.00	40,080.00
Virginia (Hampton).....	77,000.00	26,000.00	500.00			1,500.00		106,400.27
Washington.....		5,692.85	1,206.84	1,350.18	61,400.27	705.00		13,899.03
West Virginia (Morgantown).....			6,000.00		3,544.16		1,400.00	7,400.00
West Virginia (Institute).....		10,500.00	200.00		1,400.00	240.00	250.00	11,190.00
Wisconsin.....		95,422.53	12,249.27		3,000.00	3,063.45	12,822.83	148,484.64
Wyoming.....		16,750.00	2,300.00	1,220.20	24,926.56	192.03	438.27	23,171.96
Total.....	626,916.56	1,426,330.31	135,312.46	104,247.94	169,182.24	51,140.96	230,552.91	2,743,683.38

^aIncluding apparatus, machinery, and live stock.

^bIncluding apparatus.

TABLE 7.—Disbursements from the United States Treasury to the States and Territories of the appropriations in aid of colleges of agriculture and the mechanic arts under the act of Congress approved August 30, 1890.^a

State or Territory.	Year ending June 30—											
	1890.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.
Alabama.....	\$15,000	\$16,000	\$17,000	\$18,000	\$19,000	\$20,000	\$21,000	\$22,000	\$23,000	\$24,000	\$25,000	\$25,000
Arizona.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Arkansas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
California.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Colorado.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Connecticut.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Delaware.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Florida.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Georgia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Idaho.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Illinois.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Iowa.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Kansas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Kentucky.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Louisiana.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Maine.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Maryland.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Massachusetts.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Michigan.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Minnesota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Missouri.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Montana.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Nebraska.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Nevada.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
New Hampshire.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
New Jersey.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
New Mexico.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
New York.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
North Carolina.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
North Dakota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Ohio.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Oklahoma.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Oregon.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Pennsylvania.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Rhode Island.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
South Carolina.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
South Dakota.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Tennessee.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000
Texas.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000

Utah.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
Vermont.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
Virginia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
Washington.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
West Virginia.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
Wisconsin.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
Wyoming.....	15,000	16,000	17,000	18,000	19,000	20,000	21,000	22,000	23,000	24,000	25,000	25,000	25,000
Total	650,000	704,000	782,000	864,000	912,000	960,000	1,008,000	1,056,000	1,104,000	1,152,000	1,200,000	1,200,000	1,200,000

^a From the annual statement of Commissioner of Education to the Secretary of the Interior, 1903.

STATISTICS OF THE AGRICUL

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Alabama (College)	Auburn	J. F. Duggar	Feb. —, 1883	Feb. 24, 1888
Alabama (Canebrake) ..	Uniontown	J. M. Richeson	Jan. 1, 1886	Apr. 1, 1888
Alabama	Tuskegee	G. W. Carver	Feb. 15, 1897	.....
Arizona	Tucson	R. H. Forbes .....	.....	1889
Arkansas	Fayetteville	W. G. Vincenheller ..	.....	1887
California	Berkeley	E. W. Hilgard	1875	Mar. —, 1888
Colorado	Fort Collins	L. G. Carpenter	1879	Feb. —, 1888
Connecticut (State)....	New Haven	E. H. Jenkins	Oct. 1, 1875	May 18, 1887
Connecticut (Storrs) ..	Storrs	L. A. Clinton .....	.....	do
Delaware	Newark	A. T. Neale .....	.....	Feb. 21, 1888
Florida	Lake City	T. H. Taliaferro .....	.....	1888
Georgia	Experiment	R. J. Redding	Feb. 18, 1888	July 1, 1889
Idaho	Moscow	H. T. French .....	.....	Feb. 26, 1892
Illinois	Urbana	E. Davenport .....	.....	Mar. 21, 1888
Indiana	Lafayette	A. Goss	1885	Jan. —, 1888
Iowa	Ames	C. F. Curtiss .....	.....	Feb. 17, 1888
Kansas	Manhattan	J. T. Willard .....	.....	Feb. 8, 1888
Kentucky	Lexington	M. A. Scovell	Sept. —, 1885	April —, 1888
Louisiana (sugar)	New Orleans	W. C. Stubbs	Sept. —, 1885	.....
Louisiana (State)	Baton Rouge	do	Apr. —, 1886	.....
Louisiana (North).....	Calhoun	do	May —, 1887	.....
Maine	Orono	C. D. Woods	Mar. —, 1885	Oct. 1, 1887
Maryland	College Park	H. J. Patterson	1888	April —, 1888

TURAL EXPERIMENT STATIONS.

statistics, 1903.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1902-3.		Number of addresses on mailing list.	Principal lines of work.
			Number.	Pages.		
12	8	7	6	226	11,000	Botany, soils; analyses of fertilizers and food materials, field and pot experiments; horticulture; plant breeding; diseases of plants; feeding experiments; diseases of animals; dairying.
3					300	Soil improvement; field experiments; horticulture; floriculture; diseases of plants; diseases of animals; dairying.
10	10				2,000	Field experiments; horticulture; diseases of plants; animal industry; dairying.
6	3	1	5	239	5,400	Chemistry, botany; field experiments; improvement of ranges; horticulture, including date-palm culture; feeding experiments; irrigation.
5	2	3	5	110	6,000	Chemistry of foods; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; diseases of animals.
30	17	12	11	654	8,500	Physics; chemistry and geographical distribution of soils; bacteriology; fertilizers; fertilizer control; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; beet-sugar chemistry; chemistry of foods and feeding stuffs; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; animal and plant pathology.
16	8	8	18	462	7,500	Chemistry; field experiments; horticulture; plant breeding; entomology; irrigation.
17	.....	4	6	591	1,188	Chemistry; analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; diseases of plants; horticulture; forestry; field experiments; entomology.
14	11	1	3	300	8,000	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; horticulture; poultry experiments; dairying.
6	6	6	5	286	7,365	Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
14	7	1	9	253	4,400	Chemistry; field experiments; horticulture; feeding experiments; veterinary science; entomology.
7	1	4	5	147	9,500	Field experiments; horticulture; entomology; pig feeding; dairying.
8	5	6	6	175	3,900	Chemistry; physics; botany; field experiments; horticulture; entomology; feeding experiments.
28	11	15	6	104	20,000	Chemistry; bacteriology; field experiments; horticulture; forestry; plant breeding; diseases of plants; diseases of animals; feeding experiments; entomology; dairying.
10	8	10	3	113	10,000	Chemistry; soils; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals; irrigation; dairying.
22	13	6	7	145	17,000	Chemistry; botany; field experiments; horticulture; diseases of plants; feeding experiments; animal husbandry; entomology; dairying.
18	13	15	9	252	25,172	Soils; horticulture; plant breeding, field experiments; feeding and digestion experiments; diseases of animals; entomology; dairying; extermination of prairie dogs and gophers.
18	1	1	7	516	8,500	Chemistry; soils; analysis of fertilizers, foods, and feeding stuffs; inspection of orchards and nurseries; field experiments; horticulture; plant breeding; animal husbandry; feeding experiments; diseases of plants; entomology; dairying.
23	5	9	9	318	15,000	Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.
						Geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology.
12	5	3	11	380	9,000	Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying.
						Chemistry; botany; analysis and inspection of fertilizers, concentrated commercial feeding stuffs, and creamery glassware; horticulture; diseases of plants; seed tests; food and nutrition of man and animals; poultry raising; diseases of animals; entomology; dairying.
14	9	6	6	232	12,500	Chemistry; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; animal breeding; diseases of animals; entomology; dairying.

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
Massachusetts.....	Amherst.....	H. H. Goodell.....	a 1882	Mar. 2, 1888
Michigan.....	Agricultural College..	C. D. Smith.....		Feb. 26, 1888
Minnesota.....	St. Anthony Park, St. Paul.	W. M. Liggett.....	Mar. 7, 1885	1888
Mississippi.....	Agricultural College..	W. L. Hutchinson ..		Jan. 27, 1888
Missouri (State).....	Columbia.....	H. J. Waters.....		Jan. —, 1888
Missouri (fruit).....	Mountain Grove.....	P. Evans.....	Feb. 1, 1900	
Montana.....	Bozeman.....	S. Fortier.....		July 1, 1893
Nebraska.....	Lincoln.....	E. A. Burnett.....	Dec. 16, 1884	June 13, 1887
Nevada.....	Reno.....	J. E. Stubbs.....		
New Hampshire.....	Durham.....	W. D. Gibbs.....	1886	Aug. 4, 1887
New Jersey (State).....	New Brunswick.....	E. B. Voorhees.....	Mar. 10, 1880	
New Jersey (college).....	do.....	do.....		April 26, 1888
New Mexico.....	Mesilla Park.....	L. Foster.....		Dec. 14, 1889
New York (State).....	Geneva.....	W. H. Jordan.....	Mar. —, 1882	
		*		
New York (Cornell)....	Ithaca.....	L. H. Bailey.....	1879	April —, 1888
North Carolina.....	Raleigh.....	B. W. Kilgore.....	Mar. 12, 1877	Mar. 7, 1887
North Dakota.....	Agricultural College..	J. H. Worst.....		Mar. —, 1890
Ohio.....	Wooster.....	C. E. Thorne.....	April 25, 1882	April 2, 1888
Oklahoma.....	Stillwater.....	John Fields.....		Dec. 25, 1890
Oregon.....	Corvallis.....	J. Withycombe.....		July —, 1888
Pennsylvania.....	State College.....	H. P. Armsby.....		June 30, 1887
Rhode Island.....	Kingston.....	H. J. Wheeler.....		July 30, 1888
South Carolina.....	Clemson College.....	P. H. Mell.....		Jan. —, 1888

a In 1882 the State organized a station here and maintained it until June 18, 1895, when it became a part of the Hatch Station at the same place.

statistics, 1903—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1902-3.		Number of addresses on mailing list.	Principal lines of work.
			Number.	Pages.		
24	8	6	8	682	16,000	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments; horticulture; electro-germination; diseases of plants; digestion and feeding experiments; diseases of animals; entomology; dairying.
15	7	6	12	532	30,000	Chemistry; bacteriology; soils; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; stable hygiene.
15	7	-----	6	280	13,500	Chemistry; soils; field experiments; horticulture; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying.
12	5	7	6	172	18,000	Soils; fertilizers; field experiments; horticulture; animal husbandry; diseases of animals; entomology; dairying.
20	13	12	7	184	3,000	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; animal and plant breeding; diseases of animals; entomology; dairying; irrigation.
4	-----	-----	6	112	4,500	Horticulture; entomology; inspection of orchards and nurseries.
9	8	8	11	338	5,400	Chemistry; meteorology; botany; field experiments; horticulture; feeding experiments; poultry experiments; entomology; dairying; irrigation.
18	12	8	6	260	19,000	Chemistry; botany; meteorology; soils; field experiments; horticulture; diseases of plants; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation.
10	6	6	1	124	2,500	Chemistry; botany; soils; field experiments; horticulture; forestry; animal diseases; entomology; irrigation.
12	8	8	15	290	12,000	Chemistry; field experiments; horticulture; feeding experiments; entomology.
13 7	2 5	4 5	8	784	11,000	Chemistry; biology; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments; horticulture; diseases of plants; food and nutrition of man; diseases of animals; entomology; dairy husbandry; soil bacteriology; irrigation.
11	8	9	4	122	2,500	Chemistry; botany; field experiments; horticulture; soils; feeding experiments; entomology; irrigation.
23	-----	12	19	967	41,719	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of feeding stuffs, Paris green, and creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
24	12	12	4	108	20,000	Chemistry; soils; fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; poultry experiments; entomology; dairying.
13	6	6	4	156	26,000	Chemistry; soils; field experiments; horticulture; plant diseases; animal husbandry; diseases of animals; poultry experiments; dairying; tests of farm machinery.
12	8	4	5	260	10,000	Chemistry; botany; field experiments; plant breeding; horticulture; diseases of plants; food analysis; feeding experiments; diseases of animals; dairying; tests of farm machinery.
18	-----	4	9	224	43,000	Soils; field experiments; horticulture; plant breeding; diseases of plants; breeding and feeding experiments; diseases of animals; entomology.
11	8	5	5	158	19,140	Chemistry; field experiments; horticulture; forestry; botany; diseases of plants; animal husbandry; diseases of animals; entomology.
13	10	5	4	68	4,500	Chemistry; bacteriology; soils; field crops; horticulture; diseases of plants; feeding experiments; entomology; dairying.
15	6	3	5	515	15,000	Chemistry; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture; field experiments; feeding experiments; dairying.
11	3	3	8	171	8,310	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry experiments.
15	11	11	10	198	10,700	Chemistry; analysis and control of fertilizers; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying.

TABLE 8.—*General*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.
South Dakota	Brookings	J. W. Wilson		Mar. 13, 1887
Tennessee	Knoxville	A. M. Soule	June 8, 1882	Aug. 4, 1887
Texas	College Station	J. A. Craig		
Utah	Logan	J. A. Widtsoe		1890
Vermont	Burlington	J. L. Hills	Nov. 24, 1886	Feb. 28, 1888
Virginia	Blacksburg	J. M. McBryde	1888	1891
Washington	Pullman	E. A. Bryan		1891
West Virginia	Morgantown	J. H. Stewart		June 11, 1888
Wisconsin	Madison	W. A. Henry	1883	1887
Wyoming	Laramie	B. C. Buffum	1887	Mar. 1, 1891
Total				

statistics, 1903—Continued.

Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1902-3.		Number of addresses on mailing list.	Principal lines of work.
			Number.	Pages.		
19	8	.....	5	257	9,000	Soils; field experiments; plant breeding; diseases of plants and animals; animal husbandry.
12	8	8	5	104	10,937	Chemistry; soils; fertilizers; field experiments; horticulture; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying.
13	5	5	3	66	12,000	Chemistry; meteorology; soils; field experiments; horticulture; feeding experiments; diseases of animals; irrigation.
15	9	9	6	272	6,000	Chemistry of soils and feeding stuffs; alkali soil investigations; meteorology; field experiments; horticulture; diseases of plants; breeding and feeding experiments; dairying; poultry experiments; irrigation; arid farming.
12	5	3	5	215	12,400	Chemistry; botany; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; dairying.
13	6	4	14	208	12,000	Field crops; horticulture; bacteriology; analysis of foods; feeding experiments; veterinary science; entomology; cider and vinegar making; ferments.
12	7	8	8	262	5,000	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; oyster culture; diseases of animals; entomology; dairying; irrigation.
13	7	7	7	236	9,400	Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; diseases of plants; inspection of orchards and nurseries; feeding experiments; poultry experiments; entomology; dairying.
20	17	5	8	510	13,000	Chemistry; bacteriology; soils; field experiments; horticulture; feeding experiments; dairying; drainage and irrigation.
10	7	.....	7	383	3,000	Chemistry; geology; botany; meteorology; waters; soils; range improvement; fertilizers; field experiments; food analysis; breeding and feeding experiments; poultry experiments; entomology; irrigation.
757	375	323	371	14,751	620,731	

TABLE 9.—Revenue and addi

Station.	Hatch fund.	State.	Individuals and communities.	Fees.	Farm products.
Alabama (College).....	\$15,000.00			\$8,137.06	\$566.85
Alabama (Canebrake).....		\$2,493.76			383.75
Alabama (Tuskegee).....		1,500.00			
Arizona.....	15,000.00	741.89			1,694.21
Arkansas.....	15,000.00				914.79
California.....	15,000.00				1,243.14
Colorado.....	15,000.00				133.67
Connecticut (State).....	7,500.00	15,500.00	\$10,340.00	3,019.64	61.97
Connecticut (Storrs).....	7,500.00	1,800.00			
Delaware.....	15,000.00				
Florida.....	15,000.00				1,650.08
Georgia.....	15,000.00	784.67			1,739.64
Idaho.....	15,000.00	1,069.82			1,408.61
Illinois.....	15,000.00	54,000.00		630.00	945.02
Indiana.....	15,000.00				a 2,315.92
Iowa.....	15,000.00	10,000.00	200.00	51.00	4,752.91
Kansas.....	15,000.00	c 3,000.00			5,511.61
Kentucky.....	15,000.00	a 5,712.99		a 35,177.36	a 9,216.50
Louisiana.....	15,000.00	20,000.00		10,000.00	1,869.30
Maine.....	15,000.00			3,510.85	2,818.92
Maryland.....	15,000.00	5,000.00			4,257.58
Massachusetts.....	15,000.00	11,200.00		4,215.25	2,298.12
Michigan.....	15,000.00	c 5,000.00		2,120.00	2,681.10
Minnesota.....	15,000.00	d 43,882.06			d 13,137.14
Mississippi.....	15,000.00				808.07
Missouri (State).....	15,000.00			2,488.41	f 2,838.46
Missouri (Fruit).....		g 32,000.00			
Montana.....	15,000.00	5,120.97			4,568.60
Nebraska.....	15,000.00				4,865.78
Nevada.....	15,000.00				345.23
New Hampshire.....	15,000.00			1,209.97	
New Jersey (State).....		24,500.00			
New Jersey (College).....	15,000.00				
New Mexico.....	15,000.00	750.00			1,865.91
New York (State).....	1,500.00	90,258.16			
New York (Cornell).....	13,500.00	i 19,833.34			
North Carolina.....	15,000.00	j 5,000.00			
North Dakota.....	15,000.00				3,044.44
Ohio.....	15,000.00	47,483.93		393.05	a 5,862.78
Oklahoma.....	15,000.00				a 3,538.82
Oregon.....	15,000.00				1,445.64
Pennsylvania.....	15,000.00			11,220.00	2,547.08
Rhode Island.....	15,000.00				1,227.92
South Carolina.....	15,000.00				1,687.63
South Dakota.....	15,000.00	1,200.00			
Tennessee.....	15,000.00				5,582.67
Texas.....	15,000.00	5,000.00			
Utah.....	15,000.00				3,634.64
Vermont.....	15,000.00	1,090.99		2,603.22	
Virginia.....	15,000.00				346.32
Washington.....	15,000.00	2,339.83			
West Virginia.....	15,000.00			13,068.00	932.00
Wisconsin.....	15,000.00	15,000.00		1,800.00	
Wyoming.....	15,000.00		120.00	220.39	385.10
Total.....	720,000.00	431,262.41	10,660.00	99,864.23	105,128.02

a Including balance from previous year.

b Balance from previous year.

c For substations.

d Including substations.

e For substation, including farm land.

f Of this amount \$2,520.31 is from cattle sales.

tions to equipment in 1903.

Miscel- laneous.	Total.	Additions to equipment in 1903.						
		Buildings.	Library.	Appa- ratus.	Farm imple- ments.	Live stock.	Miscel- laneous.	Total.
\$377.69	\$24,081.60	\$735.00	\$500.00	\$810.00	\$115.00	\$366.00	\$75.00	\$2,601.00
	2,877.51							
	1,500.00							
53.06	17,489.16	195.94	7.33	244.59	679.95	582.45	96.66	1,806.92
	15,914.79	300.79	168.26	27.50	22.50	785.00		1,304.05
	16,243.14	58.57	28.28	377.81	252.99	2.00		719.68
a 991.05	16,127.72	37.50	24.00	625.75		150.00	328.50	1,165.75
20.29	36,441.90		1,084.24	305.97	79.30			1,469.51
33.55	9,333.55			582.06	2.00	80.50	169.40	1,208.86
	15,000.00	749.83	458.07	831.10	45.89	21.75		2,106.64
	16,650.08	500.00	46.63	429.79	255.06	105.00	362.50	1,698.98
4,289.75	21,814.06	700.00	53.00	16.00	275.00			1,044.00
	17,478.43	205.69	139.92	47.50	331.30	123.00	80.75	928.16
b 331.61	70,006.63	128.67	103.38	109.86	347.05	2.50	90.02	781.48
1,484.63	18,800.55	1,422.56	117.97	428.85	588.69	59.00		2,617.07
824.24	30,828.15	750.00	14.60	729.81	816.80	2,402.14		4,713.35
b 1,743.18	25,254.79	506.17	79.75	712.39	48.53	82.60	243.40	1,672.84
a 619.81	65,726.66	10,961.26	376.16	100.38	700.34	2,657.43	2.90	14,798.47
a 11,218.62	58,087.92	1,096.81	287.71	26.71	602.57	291.35	2,425.93	4,731.08
b 28.06	21,357.83		276.93	110.71	227.20	222.11		836.95
b 20.40	24,277.98		285.38	158.41	304.04	360.00		1,585.37
3,291.04	36,004.41		84.09	283.31	196.13		113.60	563.53
a 2,824.69	27,625.79	2,173.36	360.39	993.21	224.25		99.10	3,850.31
	72,019.20	2,081.40	1,000.00	10.60	553.54	3,797.42		7,442.96
a 1,409.30	17,217.37	43,800.00	c 61.79	252.09	351.05	295.00	c 5,455.43	10,215.36
a 3,229.61	23,556.51	78,150.00	222.61	621.35	135.40	937.00		50,066.36
	32,000.00	1,200.00						1,200.00
	24,689.57	6,300.00	100.00	300.00	100.00			6,800.00
	19,665.78		4.77	560.06	425.78			990.61
b 226.56	15,571.89	404.84	66.63	175.04	237.42	266.21		1,150.14
	16,209.97	61.00	300.00	226.00	8.00			869.00
	24,500.00		103.69	288.99				674.56
	15,000.00		550.33	191.95	130.00		274.00	1,322.19
	17,615.91	600.00	6.90	100.00	700.00	512.00	300.00	2,218.90
a 7,304.55	99,062.71	10,500.00	692.59	27.55	1,947.00	255.00		13,422.14
	33,333.34	141.38	78.71	385.89	85.57	300.00	400.00	1,391.55
a 2,883.70	22,883.70	768.44	51.27	112.94	178.35	151.48		1,262.48
477.22	18,521.66	142.60	3.72	422.94	20.00	440.00	50.12	1,079.38
1,959.96	70,699.72	2,403.54	265.17	25.30	401.48	3,222.34	232.98	6,550.81
	18,538.82	750.00	69.19	325.09	300.00		305.34	1,749.62
	16,445.64		75.16	37.50	229.05	62.40		404.11
181.64	28,948.72		62.68	2,596.58	68.85		35.93	2,764.04
a 1,251.50	17,479.42	264.51	274.78	342.23	306.43			1,187.95
	16,687.63	586.39	194.66	454.00	121.65	227.65		1,584.55
	954.16	5.90	15.76	216.10	302.92	74.10	198.12	812.90
102.49	20,685.16	400.00	270.00	63.04	278.33	150.00	112.50	1,273.87
8,737.01	28,737.01	252.40	200.72	386.03	84.30	75.00	115.45	1,113.90
	18,634.64	748.71	93.17	5.55	568.83	1,040.01	16,117.14	18,573.41
	18,094.21	930.67	101.50	409.51	730.57	665.00		2,837.25
73.85	18,629.18	267.89		183.84				451.73
b 1,289.35	15,420.17	249.00		261.89	26.80		59.83	597.52
2,087.50	31,087.50	1,919.81	891.31	1,232.01	197.27	448.35	4,369.23	9,057.98
	31,800.00		846.00	310.00	302.00	1,024.00		2,482.00
	15,725.49	1,391.49	402.15	76.60	218.80	192.03	338.27	2,619.34
60,323.07	1,427,237.73	135,581.16	11,501.35	18,552.41	15,123.98	22,427.82	33,183.89	236,370.61

a For biennial period 1903 and 1904.

A Insurance.

i Estimated amount of State and other appropriations not included in Hatch fund spent for experimental purposes.

j Estimated amount of State appropriation spent for experimental purposes.

k Including farm products.

TABLE 10.—*Expenditures from United States*

Station.	Amount.	Itemized.						
		Salaries.	Labor.	Publica- tions.	Postage and station- ery.	Freight and ex- press.	Heat, light, and water.	Chem- ical sup- plies.
Alabama	\$15,000.00	\$8,828.91	\$1,367.62	\$799.69	\$147.58	\$266.12	\$308.29	\$408.78
Arizona	15,000.00	8,259.64	1,874.15	1,147.13	136.60	188.06	135.95	163.99
Arkansas	15,000.00	7,374.86	2,168.45	704.05	303.41	397.04	86.51	292.03
California	15,000.00	6,007.12	5,158.21	227.25	438.49	124.68	268.61	213.79
Colorado	15,000.00	10,992.81	62.57	1,953.76	157.37	9.15	6.00	.....
Connecticut (State)	7,500.00	7,500.00	.....	.....	.....	.....	.....	.....
Connecticut (Storrs)	7,500.00	4,016.54	999.48	158.78	165.55	78.91	58.91	86.76
Delaware	15,000.00	9,270.50	1,067.01	818.94	128.90	91.89	266.01	98.54
Florida	15,000.00	7,655.36	2,471.59	608.61	194.14	212.77	447.69	104.69
Georgia	15,000.00	7,430.00	2,605.03	887.91	200.63	237.41	224.70	2.15
Idaho	15,000.00	7,878.15	3,085.27	836.56	21.80	91.93	871.76	139.81
Illinois	15,000.00	7,076.42	2,644.51	1,626.64	890.27	356.19	547.86	30.13
Indiana	15,000.00	7,253.48	3,410.81	757.13	103.45	90.92	220.52	3.59
Iowa	15,000.00	7,875.94	2,412.70	1,504.07	536.17	289.71	230.72	246.90
Kansas	15,000.00	8,190.58	3,388.54	430.50	113.80	283.01	9.10	28.82
Kentucky	15,000.00	11,720.00	483.42	1,083.36	127.95	55.33	343.00	194.56
Louisiana	15,000.00	7,120.51	3,196.33	1,423.50	383.01	205.39	226.90	86.54
Maine	15,000.00	7,939.45	1,808.42	22.75	278.74	149.12	954.60	177.96
Maryland	15,000.00	7,799.00	2,988.59	264.84	183.28	203.74	332.21	158.70
Massachusetts	15,000.00	6,829.37	3,216.52	860.08	360.32	130.65	355.77	.....
Michigan	15,000.00	6,364.06	2,971.97	186.29	307.64	312.82	.....	107.35
Minnesota	15,000.00	10,507.38	2,129.00	607.70	95.21	.....	48.53	.....
Mississippi	15,000.00	7,480.53	1,457.05	1,519.07	160.64	258.14	102.73	.85
Missouri	15,000.00	6,174.58	2,920.45	1,045.75	369.33	490.58	248.84	66.17
Montana	15,000.00	8,818.50	2,218.85	1,368.87	250.21	356.25	284.67	217.60
Nebraska	15,000.00	8,774.69	1,200.00	1,229.87	506.60	83.16	.....	206.05
Nevada	15,000.00	8,221.35	2,023.15	2,117.18	141.43	117.80	347.02	112.79
New Hampshire	15,000.00	9,306.88	1,379.52	1,570.67	105.81	218.19	387.29	97.81
New Jersey	15,000.00	9,730.00	901.18	1,241.64	379.53	97.48	385.57	80.96
New Mexico	15,000.00	7,579.94	1,749.22	277.26	375.38	833.33	238.35	417.56
New York (State)	1,500.00	120.00	.....	549.90	284.35	.....	125.00	41.95
New York (Cornell)	13,500.00	8,236.97	1,810.63	625.93	279.41	126.71	15.26	50.95
North Carolina	15,000.00	8,953.32	1,659.51	1,117.98	263.75	175.28	22.75	51.76
North Dakota	15,000.00	7,741.85	3,056.31	769.88	376.25	150.47	777.46	59.68
Ohio	15,000.00	9,667.92	2,867.38	.....	41.41	.....	299.23	.....
Oklahoma	15,000.00	6,655.00	2,500.00	1,260.10	413.44	245.14	279.46	177.63
Oregon	15,000.00	10,599.25	2,006.06	93.32	117.37	172.99	.....	610.78
Pennsylvania	15,000.00	10,306.20	.....	174.13	338.36	.....	1,422.65	633.06
Rhode Island	15,000.00	7,794.97	2,334.53	.....	218.96	142.35	785.11	53.72
South Carolina	15,000.00	8,579.76	2,244.55	935.13	159.58	227.85	101.42	378.90
South Dakota	15,000.00	9,435.00	1,538.52	1,187.46	184.12	191.29	11.73	293.20
Tennessee	15,000.00	8,035.81	3,453.32	749.45	320.37	47.50	292.52	196.15
Texas	15,000.00	9,467.08	1,405.62	607.58	290.99	371.19	54.56	289.34
Utah	15,000.00	6,645.41	4,141.94	363.66	202.50	5.75	242.26	205.80
Vermont	15,000.00	6,682.23	2,775.78	799.13	465.19	66.95	442.74	287.27
Virginia	15,000.00	8,847.37	2,478.65	1,394.77	102.75	126.20	205.78	295.37
Washington	15,000.00	9,859.71	1,933.20	773.52	100.34	178.07	996.71	49.36
West Virginia	15,000.00	11,341.36	.....	123.74	369.71	19.51	335.66	232.14
Wisconsin	15,000.00	8,357.97	1,874.88	279.92	116.25	429.12	228.77	136.93
Wyoming	15,000.00	6,085.60	3,120.03	1,494.52	507.44	224.40	708.94	223.42
Total	720,000.00	403,389.33	104,560.52	40,579.87	12,715.78	9,130.54	15,286.12	8,012.29

appropriation for year ended June 30, 1903.^a

Itemized.											
Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Building and repairs.	Balance.
\$687.81	\$342.07	\$317.57	\$500.45	\$72.89	\$118.37	\$398.38	\$17.25		\$15.00	\$403.22	
223.75	429.04	454.58	7.33	679.95	96.66	80.60	582.45	\$344.18		195.94	
974.53		803.30	168.26	22.50		27.50	785.00	485.44	106.00	300.79	\$0.33
680.00		161.62	28.28	252.99	51.00	377.84	2.00	949.55		58.57	
86.06			16.00	15.00	58.09	392.56		1,191.63	59.00		
294.94		29.50	35.20	2.00	154.21	582.06	80.50	366.76	15.00	374.90	
363.28		52.21	458.07	45.89	86.12	831.10	21.75	542.85	107.11	749.83	
290.67	646.39	885.59	46.03	194.90		294.20	105.00	267.50	42.10	532.17	
781.40	406.47	993.74	52.90	273.69		16.40		100.83	36.74	750.00	
181.61	9.58	198.15	115.27	379.32	80.75	47.50	5.00	170.50	149.00	738.04	
587.16	8.10	94.28	103.38	347.05	90.02	109.86	2.50	225.65	131.41	128.67	
565.31		1,014.29	117.97	588.69		428.85	11.00	77.66	6.62	349.71	
908.67			11.60	75.00	30.00	38.00		68.02	19.50	750.00	
463.16		262.94	79.75	49.53	243.40	640.68	82.60	200.67	25.75	507.17	
274.90			360.66	40.85	2.90	100.38		34.90	114.65	63.14	
311.85	152.49	708.78	287.71	578.93		26.71	291.35				
502.14	142.80	1,372.06	276.93	227.20	331.39	110.71	222.11	279.87	15.00	188.75	
705.43	175.26	300.50	285.38	304.04	113.60	158.41	360.00	228.08	15.00	363.94	
810.76	716.85	587.17	56.18	196.13	35.03	87.90		105.50	121.00	530.77	
379.26	3.28	499.93	359.37	84.89	83.66	874.24	1,571.55	390.05	8.48	495.16	
236.38		1,129.55		60.25			186.00				
629.30	205.58	1,117.01	149.31	236.21	253.73		422.50	243.38	15.00	748.97	
797.47	20.10	1,297.93	186.15	135.40	329.05	314.63	74.00	365.92	15.00	148.65	
499.15	40.80		235.18	237.71	300.00	107.21			65.00		
560.49		674.69	4.77	425.78	53.75	560.06	58.00	36.55	15.00	610.54	
592.12			15.60	21.47	266.21	62.25		523.29	33.50	404.84	
380.42	49.90		316.87	25.14	70.50	382.44		558.72	15.00	134.84	
139.35	177.02		550.33	130.00	100.50	191.95		273.58	171.00	449.91	
513.05	108.00	706.87	6.90	685.22	114.17	79.64	512.00	768.11	35.00		
47.50	144.50	14.00					105.00		67.80		
481.47	175.50	18.22	78.71	85.57	425.36	385.89	300.00	205.31	53.00	145.11	
460.01	192.09	550.90	51.27	262.62		112.94	151.48	187.68	86.02	700.64	
325.60		486.60	3.72	100.96	50.12	375.72	410.00	132.50	66.75	86.13	
948.73	381.92	245.34		305.69	22.20		50.00	102.25	15.00	52.93	
244.73	33.00	628.80	5.90	324.23	304.59	323.53	517.68	321.77	15.00	750.00	
336.07	11.00	362.87	75.16	229.05		37.50	62.40	252.38	21.00	12.80	
15.64	71.41	1,270.96	294.11	6.90		131.75	60.98	180.46	43.80	49.59	
834.12	229.17	570.92	274.78	306.43	628.40	342.23		203.80	16.00	264.51	
298.17	136.38	84.47	194.66	121.65	58.60	75.10	227.65	574.54	15.00	586.59	
498.23	10.13	413.59	15.76	302.92	192.58	362.15	74.10	238.32	15.00	5.90	
353.16	145.04	123.49	275.27	278.33	112.50	63.04		238.45	59.05	256.55	
546.36	3.75	433.11	200.72	84.30	115.45	386.03	75.00	194.40	222.12	252.40	
197.55	106.45	625.38	93.17	395.76	42.73		1,026.86	265.90		438.88	
111.10	75.61	1,178.24	99.00	104.63	127.35	409.51		478.83	116.44	750.00	
836.28	185.60					183.84		40.50	35.00	267.89	
414.74		18.40		26.80				400.15		249.00	
151.49	127.62	61.69	520.66	129.00	12.40	1,231.51	45.00	283.51	15.00		
1,720.31	1.50	75.70	498.60	64.82		332.95	102.00	502.60	106.48	171.20	
596.86	5.15	209.37	2.15	218.80	338.27	76.60	192.03	233.37	13.05	750.00	
23,928.54	5,609.55	21,064.31	7,519.07	9,737.08	5,498.66	12,152.35	8,822.74	13,835.91	2,333.37	15,768.64	0.33

^aThe expenditures under the different heads are affected by the total revenue of the station, as shown in Table 9.

TABLE 11.—Disbursements from the United States Treasury to the States and Territories

State or Territory.	1888.	1889.	1890.	1891.	1892.	1893.	1894.
Alabama.....	\$11,250.00	\$18,750.00	\$14,999.31	\$15,000.00	\$15,000.00	\$15,000.00	\$15,000.00
Arizona.....			10,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Arkansas.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
California.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Colorado.....	11,250.00	18,713.21	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Connecticut.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Dakota (Territory).....	11,250.00	18,750.00	15,000.00	11,250.00			
Delaware.....	11,250.00	18,188.84	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Florida.....	11,250.00	18,750.00	14,998.05	15,000.00	15,000.00	15,000.00	15,000.00
Georgia.....	11,250.00	18,733.55	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
I Idaho.....						15,000.00	15,000.00
Illinois.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Indiana.....	11,250.00	18,662.91	14,988.28	15,000.00	15,000.00	15,000.00	15,000.00
Iowa.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Kansas.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Kentucky.....	11,250.00	18,746.57	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Louisiana.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Maine.....	11,250.00	18,750.00	14,999.75	14,999.87	15,000.00	15,000.00	15,000.00
Maryland.....	11,250.00	18,725.28	14,998.65	15,000.00	15,000.00	15,000.00	15,000.00
Massachusetts.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Michigan.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Minnesota.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Mississippi.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Missouri.....	11,250.00	13,391.66	15,155.58	15,000.00	15,000.00	15,000.00	15,000.00
Montana.....							15,000.00
Nebraska.....	11,250.00	18,750.00	15,000.00	14,999.87	15,000.00	14,951.08	14,981.21
Nevada.....	11,250.00	18,750.00	11,951.39	15,000.00	14,999.44	15,000.00	15,000.00
New Hampshire.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
New Jersey.....	11,250.00	18,711.97	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
New Mexico.....			10,000.00	15,000.00	15,000.00	15,000.00	15,000.00
New York.....	11,250.00	18,708.09	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
North Carolina.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
North Dakota.....			17,500.00	15,000.00	15,000.00	15,000.00	14,830.62
Ohio.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Oklahoma.....					15,000.00	15,000.00	15,000.00
Oregon.....	11,250.00	11,250.00	9,132.52	15,000.00	13,791.71	16,207.59	15,000.00
Pennsylvania.....	11,250.00	18,717.95	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Rhode Island.....		15,000.00	30,000.00	15,000.00	15,000.00	15,000.00	15,000.00
South Carolina.....	11,250.00	18,750.00	15,000.00	15,000.00	14,542.15	15,000.00	15,000.00
South Dakota.....			3,750.00	15,000.00	15,000.00	15,000.00	15,000.00
Tennessee.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Texas.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Utah.....			10,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Vermont.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Virginia.....	11,250.00	18,742.57	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Washington.....					15,000.00	11,250.00	18,750.00
West Virginia.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Wisconsin.....	11,250.00	18,750.00	15,000.00	15,000.00	15,000.00	15,000.00	15,000.00
Wyoming.....				15,000.00	15,000.00	15,000.00	15,000.00
Total.....	427,500.00	713,792.63	624,523.56	602,499.74	718,333.30	702,408.67	723,561.83

* This table was prepared in the Treasury for the use of this Department

FEDERAL LEGISLATION, REGULATIONS, AND RULINGS AFFECT- ING AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

FEDERAL LEGISLATION.

ACT OF 1862 DONATING LANDS FOR AGRICULTURAL COLLEGES.

AN ACT donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be granted to the several States, for the purposes hereinafter mentioned, an amount of public land, to be apportioned to each State a quantity equal to thirty thousand acres for each Senator and Representative in Congress to which the States are respectively entitled by the apportionment under the census of eighteen hundred and sixty: *Provided,* That no mineral lands shall be selected or purchased under the provisions of this act.

SEC. 2. That the land aforesaid, after being surveyed, shall be apportioned to the several States in sections or subdivisions of sections, not less than one-quarter of a section; and whenever there are public lands in a State subject to sale at private entry at one dollar and twenty-five cents per acre, the quantity to which said State shall be entitled shall be selected from such lands within the limits of such State, and the Secretary of the Interior is hereby directed to issue to each of the States in which there is not the quantity of public lands subject to sale at private entry at one dollar and twenty-five cents per acre to which said State may be entitled under the provisions of this act land scrip to the amount in acres for the deficiency of its distributive share; said scrip to be sold by said States and the proceeds thereof applied to the uses and purposes prescribed in this act and for no other use or purpose whatsoever: *Provided,* That in no case shall any State to which land scrip may thus be issued be allowed to locate the same within the limits of any other State or of any Territory of the United States, but their assignees may thus locate said land scrip upon any of the unappropriated lands of the United States subject to sale at private entry at one dollar and twenty-five cents, or less, per acre: *And provided further,* That not more than one million acres shall be located by such assignees in any one of the States: *And provided further,* That no such location shall be made before one year from the passage of this act.

SEC. 3. That all the expenses of management, superintendence, and taxes from date of selection of said lands, previous to their sales, and all expenses incurred in the management and disbursement of the moneys which may be received therefrom, shall be paid by the States to which they may belong, out of the treasury of said States, so that the entire proceeds of the sale of said lands shall be applied without any diminution whatever to the purposes hereinafter mentioned.

SEC. 4. That all moneys derived from the sale of the lands aforesaid by the States to which the lands are apportioned, and from the sales of land scrip hereinbefore provided for, shall be invested in stocks of the United States, or of the States, or some other safe stocks, yielding not less than five per centum upon the par value of said stocks; and that the moneys so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished (except so far as may be provided in section fifth of this act), and the interest of which shall be inviolably appropri-

ated, by each State which may take and claim the benefit of this act, to the endowment, support, and maintenance of at least one college where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectfully prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.

SEC. 5. That the grant of land and land scrip hereby authorized shall be made on the following conditions, to which, as well as to the provisions hereinbefore contained, the previous assent of the several States shall be signified by legislative acts:

First. If any portion of the fund invested, as provided by the foregoing section, or any portion of the interest thereon, shall, by any action or contingency, be diminished or lost, it shall be replaced by the State to which it belongs, so that the capital of the fund shall remain forever undiminished; and the annual interest shall be regularly applied without diminution to the purposes mentioned in the fourth section of this act, except that a sum, not exceeding ten per centum upon the amount received by any State under the provisions of this act, may be expended for the purchase of lands for sites or experimental farms, whenever authorized by the respective legislatures of said States.

Second. No portion of said fund, nor the interest thereon, shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings.

Third. Any State which may take and claim the benefit of the provisions of this act shall provide, within five years, at least not less than one college, as described in the fourth section of this act, or the grant to such State shall cease; and said State shall be bound to pay the United States the amount received of any lands previously sold and that the title to purchasers under the State shall be valid.

Fourth. An annual report shall be made regarding the progress of each college, recording any improvements and experiments made, with their cost and results and such other matters, including State industrial and economical statistics, as may be supposed useful, one copy of which shall be transmitted by mail free, by each, to all the other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior.

Fifth. When lands shall be selected from those which have been raised to double the minimum price, in consequence of railroad grants, they shall be computed to the State at the maximum price and the number of acres proportionately diminished.

Sixth. No State while in a condition of rebellion or insurrection against the Government of the United States shall be entitled to the benefit of this act.

Seventh. No State shall be entitled to the benefits of this act unless it shall express its acceptance thereof by its legislature within two years from the date of its approval by the President.

SEC. 6. That land scrip issued under the provisions of this act shall not be subject to location until after the first day of January, one thousand eight hundred and sixty-three.

SEC. 7. That the land officers shall receive the same fees for locating land scrip issued under the provisions of this act as is now allowed for the location of military bounty land warrants under existing laws: *Provided*, Their maximum compensation shall not be thereby increased.

SEC. 8. That the governors of the several States to which scrip shall be issued under this act shall be required to report annually to Congress all sales made of such scrip until the whole shall be disposed of, the amount received for the same, and what appropriation has been made of the proceeds.

Approved, July 2, 1862.

ACT OF 1866 EXTENDING THE TIME WITHIN WHICH AGRICULTURAL COLLEGES MAY BE ESTABLISHED.

AN ACT to amend the fifth section of an act entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," approved July 2, 1862, so as to extend the time within which the provisions of said act shall be accepted and such colleges established.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the time in which the several States may comply with the provisions of the act of July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," is hereby extended so that the acceptance of the benefits of the said act may be expressed within three years from the passage of this act, and the colleges required by the said act may be provided within five years from the date of the filing of such acceptance with the Commissioner of the General Land Office: *Provided*, That when any Territory shall become a State and be admitted into the Union, such new State shall be entitled to the benefits of the said act of July second, eighteen hundred and sixty-two, by expressing the acceptance therein required within three years from the date of its admission into the Union, and providing the college or colleges within five years after such acceptance, as prescribed in this act: *Provided further*, That any State which has heretofore expressed its acceptance of the act herein referred to shall have the period of five years within which to provide at least one college, as described in the fourth section of said act, after the time for providing said college, according to the act of July second, eighteen hundred and sixty-two, shall have expired.

Approved, July 23, 1866.

ACT OF 1887 ESTABLISHING AGRICULTURAL EXPERIMENT STATIONS.

AN ACT to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and the acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *Provided*, That in any State or Territory in which two such colleges have been or may be so established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the legislature of such State or Territory shall otherwise direct.

SEC. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies of the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under the varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and value

of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Territories.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner [now Secretary] of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important, and, in general, to furnish such advice and assistance as will best promote the purpose of this act. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner [now Secretary] of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however,* That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such State shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any State shall have

established, under the provisions of said act of July second aforesaid, an agricultural department or experimental station in connection with any university, college, or institution not distinctly an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made to such separate agricultural college or school, and no legislature shall by contract, express or implied, disable itself from so doing.

SEC. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this act.

Approved, March 2, 1887.

ACT OF 1890 FOR THE FURTHER ENDOWMENT OF AGRICULTURAL COLLEGES.

AN ACT to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts established under the provisions of an act of Congress approved July second, eighteen hundred and sixty-two.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, arising from the sales of public lands, to be paid as hereinafter provided, to each State and Territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of Congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be twenty-five thousand dollars, to be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life and to the facilities for such instruction: *Provided*, That no money shall be paid out under this act to any State or Territory for the support and maintenance of a college where a distinction of race or color is made in the admission of students, but the establishment and maintenance of such college separately for white and colored students shall be held to be a compliance with the provisions of this act if the funds received in such State or Territory be equitably divided as hereinafter set forth: *Provided*, That in any State in which there has been one college established in pursuance of the act of July second, eighteen hundred and sixty-two, and also in which an educational institution of like character has been established, or may be hereafter established, and is now aided by such State from its own revenue, for the education of colored students in agriculture and the mechanic arts, however named or styled, or whether or not it has received money heretofore under the act to which this act is an amendment, the legislature of such State may propose and report to the Secretary of the Interior a just and equitable division of the fund to be received under this act, between one college for white students and one institution for colored students, established as aforesaid, which shall be divided into

two parts, and paid accordingly, and thereupon such institution for colored students shall be entitled to the benefits of this act and subject to its provisions, as much as it would have been if it had been included under the act of eighteen hundred and sixty-two, and the fulfillment of the foregoing provisions shall be taken as a compliance with the provisions in reference to separate colleges for white and colored students.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of colleges shall be annually paid on or before the thirty-first day of July of each year, by the Secretary of the Treasury, upon the warrant of the Secretary of the Interior, out of the Treasury of the United States, to the State or Territorial treasurer, or to such officer as shall be designated by the laws of such State or Territory to receive the same, who shall, upon the order of the trustees of the college, or the institution for colored students, immediately pay over said sums to the treasurers of the respective colleges or other institutions entitled to receive the same, and such treasurers shall be required to report to the Secretary of Agriculture and to the Secretary of the Interior, on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement. The grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of the State or Territory for the further and more complete endowment, support, and maintenance of colleges, or of institutions for colored students, as provided in this act, shall, by any action or contingency, be diminished or lost, or be misapplied, it shall be replaced by the State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings. An annual report by the president of each of said colleges shall be made to the Secretary of Agriculture, as well as to the Secretary of the Interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations attached to said colleges, with their cost and results and such other industrial and economical statistics as may be regarded as useful, one copy of which shall be transmitted by mail free to all other colleges further endowed under this act.

SEC. 4. That on or before the first day of July in each year, after the passage of this act, the Secretary of the Interior shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is entitled to receive its share of the annual appropriation for colleges, or of institutions for colored students, under this act, and the amount which thereupon each is entitled, respectively, to receive. If the Secretary of the Interior shall withhold a certificate from any State or Territory of its appropriation, the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the close of the next Congress, in order that the State or Territory may, if it should so desire, appeal to Congress from the determination of the Secretary of the Interior. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury. And the Secretary of the Interior is hereby charged with the proper administration of this law.

SEC. 5. That the Secretary of the Interior shall annually report to Congress the disbursements which have been made in all the States and Territories, and also whether the appropriation of any State or Territory has been withheld, and if so, the reasons therefor.

SEC. 6. Congress may at any time amend, suspend, or repeal any or all of the provisions of this act.

Approved, August 30, 1890.

EXTRACT FROM AN ACT MAKING APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR ENDING JUNE 30, 1903.

AGRICULTURAL EXPERIMENT STATIONS: To carry into effect the provisions of an act approved March second, eighteen hundred and eighty-seven, entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto," and to enforce the execution thereof, seven hundred and ninety-six thousand dollars; thirty-seven thousand dollars of which sum shall be payable upon the order of the Secretary of Agriculture to enable him to carry out the provisions of section three of said act of March second, eighteen hundred and eighty-seven, and fifteen thousand dollars of which sum may be expended by the Secretary of Agriculture to investigate and report to Congress upon the agricultural resources and capabilities of Alaska, and to establish and maintain agricultural experiment stations in said Territory, including the erection of buildings and all other expenses essential to the maintenance of such stations; and the Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of said act, and shall make report thereon to Congress; and the Secretary of Agriculture is hereby authorized to employ such assistants, clerks, and other persons as he may deem necessary, in the city of Washington and elsewhere, and to incur such other expenses for office fixtures and supplies, stationery, traveling, freight, and express charges, illustration of the Experiment Station Record, bulletins, and reports as he may find essential in carrying out the objects of the above acts, and the sums apportioned to the several States shall be paid quarterly in advance. And the Secretary of Agriculture is hereby authorized to furnish to such institutions or individuals as may care to buy them copies of the card index of agricultural literature prepared by the Office of Experiment Stations and charge for the same a price covering the additional expense involved in the preparation of these copies, and he is hereby authorized to apply the moneys received toward the expense of the preparation of the index. And the Secretary of Agriculture is hereby authorized to expend twelve thousand dollars of which sum to establish and maintain an agricultural station in the Hawaiian Islands, including the erection of buildings, the printing (in the Hawaiian Islands), illustration, and distribution of reports and bulletins and all other expenses essential to the maintenance of said station. And the Secretary of Agriculture is hereby authorized to expend twelve thousand dollars of which sum to establish and maintain an agricultural experiment station in Porto Rico, including the erection of buildings, the printing (in Porto Rico), illustration, and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station; and the Secretary of Agriculture is authorized to sell such products as are obtained on the land belonging to the agricultural experiment stations in Alaska, Hawaii, and Porto Rico, and to apply the moneys received from the sale of such products to the maintenance of said stations; in all, seven hundred and ninety-six thousand dollars.

NUTRITION INVESTIGATIONS: To enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for

human food, with special suggestions of full, wholesome, and edible rations less wasteful and more economical than those in common use; and the agricultural experiment stations are hereby authorized to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories and as may be mutually agreed upon; and the Secretary of Agriculture is hereby authorized to require said stations to report to him the results of any such investigations which they may carry out, whether in cooperation with said Secretary of Agriculture or otherwise, twenty thousand dollars.

IRRIGATION INVESTIGATIONS: To enable the Secretary of Agriculture to investigate and report upon the laws as affecting irrigation and the rights of riparian proprietors and institutions relating to irrigation and upon the use of irrigation waters, at home or abroad, with especial suggestions of better methods for the utilization of irrigation waters in agriculture than those in common use, and upon plans for the removal of seepage and surplus waters by drainage, and upon the use of different kinds of power for irrigation and other agricultural purposes, and for the preparation, printing, and illustration of reports and bulletins on irrigation, including employment of labor in the city of Washington or elsewhere; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories as may be mutually agreed upon, sixty-five thousand dollars.

PUBLIC ROAD INQUIRIES: To enable the Secretary of Agriculture to make inquiries in regard to the system of road management throughout the United States; to make investigations in regard to the best methods of road making, and the best kind of road-making materials in the several States; the employment of local and special agents, clerks, assistants, and other labor required in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the results of such experiments; to enable the Secretary of Agriculture to investigate the chemical and physical character of road materials, for the pay of experts, chemists, and laborers, for necessary apparatus and materials; traveling and other necessary expenses, and for preparing and publishing bulletins and reports on this subject for distribution, and to enable him to assist the agricultural colleges and experiment stations in disseminating information on this subject, thirty thousand dollars. * * *

BUREAU OF PLANT INDUSTRY, POMOLOGICAL INVESTIGATIONS: Investigating, collecting, and disseminating information relating to the fruit industry; the collection and distribution of seeds, shrubs, trees, and specimens; and for collecting and modeling fruits, vegetables, and other plants, and furnishing duplicate models to the experiment stations of the several States, as far as found practicable; the employment of investigators, local and special agents, clerks, assistants, student scientific aids at an annual salary of four hundred and eighty dollars each, and other labor required in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the results of such experiments; for all necessary office fixtures and supplies and for traveling and other necessary expenses, to continue the investigations and experiments in the introduction of the culture of European table grapes and the study of the diseases that affect them, for the purpose of discovering remedies therefor, this work to be done in cooperation with the section of seed and plant introduction; to investigate in cooperation with the other divisions and bureaus of the Department and the experiment stations of the several States the market conditions affecting the fruit and vegetable trade in the United States and foreign countries, and the methods of harvesting, packing, storing, and shipping fruit and vegetables, and for experimental shipments of fruits and vegetables to foreign countries, for the purpose of increasing the exportation of American fruits

and vegetables, and for all necessary expenses connected with the practical work of the same, and such fruits and vegetables as are needed for these investigations and experimental shipments may be bought in open market and disposed of at the discretion of the Secretary of Agriculture, and he is authorized to apply the moneys received from the sales of such fruits and vegetables toward the continuation and repetition of these investigations and experimental shipments; to investigate, map, and report upon the commercial fruit districts of the United States, for the purpose of determining the relative adaptability of the several important fruits thereto, by a study of the conditions of soil and climate, and of the prevalence of plant diseases existing therein as related to commercial fruit production, thirty thousand dollars.

BOTANICAL INVESTIGATIONS AND EXPERIMENTS: Investigations relating to medicinal, poisonous, fiber, and other economic plants, seeds, and weeds; the collection of plants, traveling expenses, and express charges; for all necessary office fixtures; the purchase of paper and all other necessary supplies, materials, and apparatus; for rent and ordinary repairs of a building for office and laboratory purposes not to exceed three thousand dollars; for gas and electric current; for the employment of investigators, local and special agents, clerks, assistants, and student scientific aids at an annual salary of four hundred and eighty dollars each, and other labor in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the result of such experiments; subscriptions to and purchase of botanical publications for use in the division; and the preparation, illustration, and publication of reports; to investigate and publish reports upon the useful plants and plant cultures of the tropical territory of the United States, and to investigate, report upon, and introduce other plants promising to be valuable for the tropical territory of the United States, such plants and botanical and agricultural information when secured to be made available for the work of agricultural experiment stations and schools; to investigate the varieties of wheat and other cereals grown in the United States or suitable for introduction, in order to standardize the naming of varieties as a basis for the experimental work of the State experiment stations, and as an assistance in commercial grading, and to investigate, in cooperation with the Bureau of Chemistry, the cause of deterioration of export grain, particularly in oceanic transit, and devise means of preventing losses from those causes, fifty-five thousand dollars.

GRASS AND FORAGE-PLANT INVESTIGATIONS: To enable the Secretary of Agriculture to conduct investigations of grasses, forage plants, and animal foods in cooperation with other divisions of the Department; to collect and purchase seeds, roots, and specimens of valuable economic grasses and forage plants for investigation; experimental cultivation and distribution, and for experiments and reports upon the best methods of extirpating Johnson and other noxious and destructive grasses; to purchase tools, all necessary office fixtures, materials, apparatus, and supplies; to pay freight, express charges, and traveling expenses; for the employment of local and special agents, clerks, assistants, and scientific student aids at an annual salary of four hundred and eighty dollars each, and other labor required in conducting experiments in the city of Washington and elsewhere; to prepare drawings and illustrations for circulars, reports, and bulletins; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in establishing and maintaining experimental grass stations, for determining the best methods of caring for and improving meadows and grazing lands, the use of different grasses and forage plants, and their adaptability to various soils and climates, the best native and foreign species for reclaiming overstocked ranges and pastures, for renovating worn-out lands, for binding drifting sands and washed lands, and for turfing lawns and pleasure grounds, and for solving the various forage problems presented in the several sections of our country, thirty thousand dollars. * * *

PURCHASE AND DISTRIBUTION OF VALUABLE SEEDS: For the purchase, propagation,

and distribution of valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants; for rent of building, not to exceed two thousand dollars; the employment of local and special agents, clerks, assistants, and other labor required, in the city of Washington and elsewhere; all necessary office fixtures, transportation, paper, twine, gum, printing, postal cards, and all necessary material and repairs for putting up and distributing the same, and to be distributed in localities adapted to their culture, two hundred and seventy thousand dollars, of which amount not more than forty-three thousand dollars shall be expended for labor in the city of Washington, District of Columbia, and not less than one hundred and eighty thousand dollars shall be allotted for Congressional distribution. * * * *Provided further*, That twenty thousand dollars of the sum thus appropriated, or so much thereof as the Secretary of Agriculture shall direct, may be used to collect, purchase, test, propagate, and distribute rare and valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants from foreign countries for experiments with reference to their introduction into this country; and the seeds, bulbs, trees, shrubs, vines, cuttings, and plants thus collected, purchased, tested, and propagated shall not be included in general distribution, but shall be used for experimental tests to be carried on with the cooperation of the agricultural experiment stations, two hundred and seventy thousand dollars, of which sum the Secretary of Agriculture is authorized to use ten thousand dollars, or so much thereof as may be necessary, for the erection of a suitable seed warehouse on the Department grounds for receiving, storing, cleaning, and properly preparing the seed handled by the Department.

REGULATIONS OF THE POST-OFFICE DEPARTMENT CONCERNING AGRICULTURAL EXPERIMENT STATION PUBLICATIONS.

Section 372 of the Postal Laws and Regulations of the United States reads as follows: Regulations for free transmission of bulletins and reports [under the act of Congress of March 2, 1887] are prescribed as follows:

(1) Any claimant of the privilege must apply for authority to exercise it to the Postmaster-General, stating the date of the establishment of such station, its proper name or designation, its official organization, and the names of its officers; the name of the university, college, school, or institution to which it is attached, if any, the legislation of the State or Territory providing for its establishment, and any other granting it the benefits of the provision made by Congress as aforesaid (accompanied by a copy of the act or acts), and whether any other such station in the same State or Territory is considered, or claims to be, also entitled to the privilege; and also the place of its location and the name of the post-office where the bulletins and reports will be mailed. The application must be signed by the officer in charge of the station.

(2) If such application be allowed after examination by the Department, the postmaster at the proper office will be instructed to admit such bulletins and reports to the mails in compliance with these regulations, and the officer in charge of the station will be notified thereof.

(3) Only such bulletins or reports as shall have been issued after the station became entitled to the benefits of the act can be transmitted free, and such bulletins or reports may be inclosed in envelopes or wrappers, sealed or unsealed. On the exterior of every envelope, wrapper, or package must be written or printed the name of the station and place of its location, the designation of the inclosed bulletin or report, and the word "Free" over the signature, or facsimile thereof, of the officer in charge of the station, to be affixed by himself or by some one duly deputed by him for that purpose. There may also be written or printed upon the envelope or wrapper a

request that the postmaster at the office of delivery will notify the mailing station of the change of address of the addressee, or other reason for inability to deliver the same, and upon a bulk package a request to the postmaster to open and distribute the "frankel" matter therein in accordance with the address thereon.

Bulletins published by the United States Department of Agriculture and analogous to those of the station, and entitled to be mailed free under the penalty envelope of that Department, may also be adopted and mailed by the several stations, with their own publications, under the same regulations, and any bulletins or reports mailable free by any agricultural experiment station under these regulations may be so mailed by any other station having free-mailing authority.

If such station's annual reports be printed by State authority, and consist in part of matter relating to the land-grant college to which such station is attached, then said report may be mailed free entire by the director of the station; provided, in his judgment, the whole consists of useful information of an agricultural character.

(4) The bulletins may be mailed to the stations, newspapers, or persons to whom they are by the foregoing act authorized to be sent, and the annual reports to any address within the United States, Canada, Mexico, or Hawaiian Kingdom (Sandwich Islands), but not to other foreign countries, free of postage.

An order of the Postmaster-General dated January 3, 1899, provides "That any article entitled to transmission free of postage in the domestic mails of the United States, either in a 'penalty' envelope or under a duly authorized 'frank,' shall be entitled likewise to transmission by mail free of postage between places in Hawaii, Cuba, Porto Rico, and the Philippine Islands; from the United States to those islands, and from those islands to the United States."

Among rulings on matters of detail the following are the most important:

"In sending out bulletins from an agricultural experiment station it is permissible to inclose postal cards to enable correspondents of the station to acknowledge the receipt of its publications and to request their continuous transmission.

"Copies of the reports or bulletins of the agricultural experiment stations, which are purchased, paid, or subscribed for, or otherwise disposed of for gain, when sent in the mails, are not entitled to free carriage under the 'frank' of the director of the station."

Station bulletins and reports, consisting of typewritten matter duplicated on a mimeograph or other duplicating machine, "retain their character as free matter when properly franked by the director of the station."

Cards upon which are printed bulletins issued by agricultural experiment stations established under the provisions of the act of March 2, 1887, may be sent openly in the mails, free of postage, provided the address side of such cards bears the indicia prescribed in paragraph 3, section 517, Postal Laws and Regulations, for envelopes used by the experiment stations referred to in mailing copies of their bulletins and reports.

Reports of State boards of agriculture or other State boards, commissioners, or officers, even though they contain station bulletins and reports, can not be sent free through the mails under the frank of the director of the station.

The catalogue of the college of which the station is a department can not be sent free through the mails under the frank of the director of the station, whether said catalogue is published separately or is bound together with a station publication.

RULINGS OF THE TREASURY DEPARTMENT AFFECTING AGRICULTURAL EXPERIMENT STATIONS.

From copies of letters addressed to the Secretary of the Treasury and others by the First Comptroller of the Treasury, relating to the construction of the act of Congress of March 2, 1887, and acts supple-

mentary thereto, the following digest has been prepared for the use of the stations. The sections are those of the act, the dates those of the decisions by the Comptroller:

SECTION 3—JANUARY 30, 1888.

That the annual financial statement of the stations, with vouchers, should not be sent to the Treasury Department, but that a copy simply of the report that is made to the governor is to be sent to the Secretary of the Treasury.

SECTION 3—JANUARY 31, 1888.

First. That the Treasury Department will not require officers of experiment stations to do or perform anything not specifically required by said bill.

Second. That the Secretary of the Treasury is not required to take a bond of the officers of said stations for the money paid over under the provisions of said act.

Third. That no reports will be required from the stations directly to the Secretary of the Treasury; but the governor of the State must send to the Secretary of the Treasury a copy of the report made to him by the colleges or stations.

SECTION 4—DECEMBER 16, 1895.

The Solicitor of the Treasury writes: "I am of the opinion that there is no authority for an agricultural experiment station to sell its bulletins outside of the State or Territory. Congress appropriates for the publication and free distribution of the bulletins, and neither expressly nor by necessary implication authorizes their sale."

SECTION 6—AUGUST 2, 1888.

The fiscal year commences on the 1st day of July, corresponding with the fiscal year of the Government.

An agricultural station entitled to the benefits of said appropriations made by Congress can anticipate the payment to be made July 1, and make contracts of purchases prior to that time, if it shall be necessary to carry on the work of the station. Of course, no portion of said appropriations paid in quarterly installments can be drawn from the Treasury unless needed for the purposes indicated in the act; and so much of what is so drawn as may not have been expended within the year must be accounted for as part of the appropriation for the following year.

SECTION 8—JANUARY 30, 1888.

The State of New York ought to designate whether to the college or to the station or to both it desires the appropriation to be applied. The eighth section of the act seems to authorize the State to apply such benefits to experimental stations it may have established as it desires.

Where there are no experimental stations connected with the colleges, the legislatures of such States must connect the agricultural experiment station with the colleges already established under the act of July 2, 1862; there is no authority in the act authorizing the establishment of agricultural experiment stations independent of said colleges.

The act contemplates that where stations have already been established disconnected from the colleges, the legislatures of such States may make such provisions in regard thereto as they may deem proper; but it does not authorize the establishment of stations except in connection with the colleges that were at that time or might thereafter be established under the act of July 2, 1862.

SECTION 8—FEBRUARY 14, 1888.

Where there is an agricultural college or station which may have been established by State authority and is maintained by the State, the eighth section of the above act would authorize the State to designate the station to which it desired the appropriation to be applied, whether to one or more, or all, and the Secretary of the Treasury should make the payment under the appropriation to whichever one the State might desire.

SECTIONS 1 AND 8—FEBRUARY 15, 1888.

(1) When an agricultural college or station has been established under the act of July 2, 1862, each college is entitled to the benefits of the provisions of said act (i. e., of March 2, 1877).

(2) In a State where an agricultural college has been established under the act of July 2, 1862, and agricultural stations have also been established, either under the act of July 2, 1862, or by State authority, before March 2, 1887, the legislature of such State shall determine which one of said institutions, or how many of them, shall receive the benefits of the act of March 2, 1887.

(3) If the legislature of any State in which an agricultural college has been established under the act of July 2, 1862, desires to establish an agricultural station which shall be entitled to the benefits of said act, it must establish such station in connection with said college.

PROVISO TO SECTIONS 1 AND 8—DECEMBER 7, 1888.

It is within the power of the legislature of any State that has accepted the provisions of said act of March 2, 1887, to dispose of the amount appropriated by Congress for said station to either one or all of the agricultural colleges or stations which may have been established in said State by virtue of either the provisions of the act of July 2, 1862, or the provisions of said eighth section of the act of March 2, 1887.

The whole responsibility rests upon the State legislature as to how the fund appropriated by Congress shall be distributed among these various institutions of the State, provided there is one or more agricultural colleges with which an agricultural station is connected, or one or more agricultural stations.

RULINGS OF THE DEPARTMENT OF AGRICULTURE ON THE WORK AND EXPENDITURES OF AGRICULTURAL EXPERIMENT STATIONS.^a

In connection with examinations of the work and expenditures of the agricultural experiment stations established in accordance with the act of Congress of March 2, 1887, under authority given to the Secretary of Agriculture by Congress, questions have arisen which have seemed to make it advisable to formulate the views of this Department on certain matters affecting the management of the stations under that act. The statements given below have therefore been prepared to cover the points which seem to require special attention:

EXPENDITURES FOR PERMANENT SUBSTATIONS.

This Department holds that the expenditure of funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, for the maintenance of permanent substations is contrary to the spirit and intent of said act. The act provides for an experiment station in each State and Territory, which, except in cases

^a U. S. Dept. Agr., Office of Experiment Stations Circular 29.

specified in the act, is to be a department of the college established under the act of Congress of July 2, 1862. The objects of the stations, as defined in the first-mentioned act, are evidently of such a character as to necessitate the services of scientific and expert workers. Most of the lines of investigation named in the act are general, rather than local, and involve scientific equipment and work. It is obviously the intent that the stations established under this act shall carry on important investigations which shall be of general benefit to the agriculture of the several States and Territories. The sum of \$15,000, which is annually appropriated by Congress under this act for each station, is only sufficient to carry out a limited number of investigations of the kind contemplated by the act.

As the work of the stations in the different States has developed, it has been found necessary to limit, rather than expand, the lines of work of the individual stations. Thorough work in a few lines has been found much more effective and productive of more useful results than small investigations in numerous lines. When we consider the nature of the investigations, the amount of money provided for the work of each station, and the fact that the act expressly provides for only a single station in connection with each college, it becomes very clear that expenditures such as are necessary to effectively maintain permanent substations ought not to be made from the funds granted by Congress to the States and Territories for experiment stations. The maintenance of permanent substations as a rule involves the erection of buildings and the making of other permanent improvements. The sums of money which can be expended for permanent improvements under the act of Congress aforesaid are so small that it is clear they were not intended to meet the needs of more than one station in each State and Territory.

When the legislature of a State or Territory has given its assent to the provisions of the act of Congress of March 2, 1887, and has designated the institution which shall receive the benefits of said act, it would seem to have exhausted its powers in the matter. The responsibility for the maintenance of an experiment station under said act devolves upon the governing board of the institution thus designated. If the legislature of the State or Territory sees fit to provide funds for the equipment and maintenance of other experiment stations and to put them under the control of the same governing board, well and good, but this does not in any way diminish the responsibility of the board to administer the funds granted by Congress in accordance with the provisions of said act.

The wisdom of Congress in limiting the number of stations to be established in each State and Territory under the aforesaid act has been clearly shown by the experience of the few States and Territories which have attempted the maintenance of substations with the funds granted under said act. The expense of maintaining substations has as a rule materially weakened the central station, and the investigations carried on at the substations have been superficial and temporary. It is granted that in many States and Territories more than one agricultural experiment station might do useful work, and in some States more than one station has already been successfully maintained; but in all these cases the State has given funds from its own treasury to supplement those given by Congress. It is also granted that experiment stations established under said act of Congress and having no other funds than those provided by that act will often need to carry on investigations in different localities in their respective States and Territories, but it is held that this should be done in such a way as will secure the thorough supervision of such investigations by the expert officers of the station and that arrangements for such experimental inquiries should not be of so permanent a character as to prevent the station from shifting its work from place to place as circumstances may require, nor involve the expenditure of funds in such amounts and in such ways as will weaken the work of the station as a whole.

As far as practicable, the cooperation of individuals and communities benefited by

these special investigations should be sought, and if necessary the aid of the States invoked to carry on enterprises too great to be successfully conducted within the limits of the appropriation granted by Congress under the act aforesaid.

PURCHASE OR RENTAL OF LANDS FOR AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that the purchase or rental of lands by the experiment stations from the funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, is contrary to the spirit and intent of said act. The act provides for "paying the necessary expenses of conducting investigations and experiments and printing and distributing the results. * * * *Provided, however,* That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such stations; and thereafter an amount not exceeding 5 per centum of such annual appropriation may be so expended." The only reference to land for the station in the act is in section 8, where State legislatures are authorized to apply appropriations made under said act to separate agricultural colleges or schools established by the State "which shall have connected therewith an experimental farm or station." The strict limitation of the amount provided for buildings and the absence of any provision for the purchase or rental of lands, when taken in connection with the statement in the eighth section, which treats the farm as in a sense a necessary adjunct of the educational institution to which the whole or a part of the funds appropriated in accordance with said act might in certain cases be devoted, point to the conclusion that it was expected that the institution of which the station is a department would supply the land needed for experimental purposes and that charges for the purchase or rental of lands would not be made against the funds provided by Congress for the experiment station. This conclusion is reinforced by consideration of a wise and economic policy in the management of agricultural experiment stations, especially as relating to cases in which it might be desirable for the station to have land for experimental purposes in different localities. The investigations carried on by the stations in such cases being for the direct benefit of agriculture in the localities where the work is done, it seems only reasonable that persons or communities whose interests will be advanced by the station work should contribute the use of the small tracts of land which will be required for experimental purposes. Experience shows that in most cases the stations have had no difficulty in securing such land as they needed, without expense, and it is believed that this may be done in every case without injuriously affecting the interests of the stations.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR CARRYING ON FARM OPERATIONS.

This Department holds that expenses incurred in conducting the operations of farms, whether the farms are connected with institutions established under the act of Congress of July 2, 1862, or not, are not a proper charge against the funds appropriated by Congress for agricultural experiment stations in accordance with the act of Congress of March 2, 1887, unless such operations definitely constitute a part of agricultural investigations or experiments planned and conducted in accordance with the terms of the act aforesaid under rules and regulations prescribed by the governing board of the station. The performance of ordinary farm operations by an experiment station does not constitute experimental work. Operations of this character by an experiment station should be confined to such as are a necessary part of experimental inquiries. Carrying on a farm for profit or as a model farm, or to secure funds which may be afterwards devoted to the erection of buildings for experiment station purposes, to the further development of experimental investiga-

tion, or to any other purpose however laudable and desirable, is not contemplated by the law as a part of the functions of an agricultural experiment station established under the act of Congress of March 2, 1887. Section 5 of that act plainly limits the expenditures of funds appropriated in accordance with said act to "the necessary expenses of conducting investigations and experiments and printing and distributing the results."

FUNDS ARISING FROM THE SALE OF FARM PRODUCTS OR OTHER PROPERTY OF AN AGRICULTURAL EXPERIMENT STATION.

This Department holds that moneys received from the sales of farm products or other property in the possession of an agricultural experiment station as the result of expenditures of funds received by the station in accordance with the act of Congress of March 2, 1887, rightfully belong to the experiment station as a department of the college or other institution with which it is connected, and may be expended in accordance with the laws or regulations governing the financial transactions of the governing board of the station, provided, however, that all expenses attending such sales, including those attending the delivery of the property into the possession of the purchaser, should be deducted from the gross receipts from the sales and should not be made a charge against the funds appropriated by Congress.

LIMIT OF EXPENDITURES OF EXPERIMENT STATIONS DURING ONE FISCAL YEAR.

This Department holds that expenses incurred by an agricultural experiment station in any one fiscal year to be paid from the funds provided under the act of Congress of March 2, 1887, should not exceed the amount appropriated to the station by Congress for that year, and especially that all personal services should be paid for out of the appropriation of the year in which they were performed, and that claims for compensation for such services can not properly be paid out of the appropriations for succeeding years. The several appropriations for experiment stations under the aforesaid act are for one year only, and officers of experiment stations have no authority to contract for expenditures beyond the year for which Congress has made appropriations.

This is plainly implied in the act aforesaid, inasmuch as section 6 provides that unexpended balances shall revert to the Treasury of the United States, "in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support." The annual financial report rendered in the form prescribed by this Department should in every case include only the receipts and expenditures of the fiscal year for which the report is made.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR A WATER SYSTEM TO BE CHARGED UNDER "BUILDINGS AND REPAIRS."

This Department holds that expenditures by agricultural experiment stations from the funds appropriated in accordance with the act of Congress of March 2, 1887, for the construction of wells, cisterns, ponds, or other reservoirs for the storage of water, and for piping, and other materials for a system of storing and distributing water, are properly charged, under abstract 18 in the schedule for financial reports prescribed by this Department, as being for improvements on lands which have hitherto been held to come under the head of "building and repairs." The fact that a water system may be a necessary adjunct of certain experimental inquiries does not affect the case, inasmuch as the limitations on expenditures for improvements contained in section 5 of the act of Congress of March 2, 1887, expressly stipulate that these improvements shall be such as are necessary for carrying on the work of the station.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR MEMBERSHIP IN AGRICULTURAL AND OTHER ORGANIZATIONS.

This Department holds that membership fees in associations and other organizations are not a proper charge against the funds appropriated by Congress in accordance with the act of March 2, 1887, except in the case of the Association of American Agricultural Colleges and Experiment Stations, which is held to be an essential part of the system of experiment stations established under said act.

THE BORROWING OF MONEY TO PAY THE EXPENSES OF AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that experiment station officers have no authority to borrow money to be repaid out of appropriations made under the act of Congress of March 2, 1887, and that charges for interest can not properly be made against funds appropriated under that act.

A. C. TRUE, *Director*.

Approved:

J. STERLING MERTON, *Secretary*.

WASHINGTON, D. C., *March 10, 1896.*

THE USE OF EXPERIMENT STATION FUNDS FOR COLLEGE PURPOSES.

This Department holds that no portion of the funds appropriated by Congress in accordance with the act of March 2, 1887, can legally be used, either directly or indirectly, for paying the salaries or wages of professors, teachers, or other persons whose duties are confined to teaching, administration, or other work in connection with the courses of instruction given in the colleges with which the stations are connected or in any other educational institution; nor should any other expenses connected with the work or facilities for instruction in school or college courses be paid from said fund. In case the same persons are employed in both the experiment station and the other departments of the college with which the station is connected a fair and equitable division of salaries or wages should be made, and in case of any other expenditures for the joint benefit of the experiment station and the other departments of the college the aforesaid funds should be charged with only a fair share of such expenditures.

Respectfully,

A. C. TRUE, *Director*.

Approved:

JAMES WILSON, *Secretary of Agriculture*.

WASHINGTON, D. C., *October 25, 1897.*

ORGANIZATION OF GOVERNING BOARDS AND RULES ADOPTED BY THEM FOR THE REGULATION OF AGRICULTURAL EXPERI- MENT STATIONS.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute,
Auburn.

Department of the Alabama Polytechnic Institute.

The Alabama Station is a department of the Alabama Polytechnic Institute and is governed by the board of trustees of the institute. There are twelve members in the board, two of whom, the governor and the State superintendent of education, are ex officio. The other members are appointed by the governor for six years, one from each Congressional district, except the district in which the institute is located, which is entitled to two members. This board has supervision of all matters pertaining to the election of officers of the station, the appropriation of its funds, and the final decision of all questions relating to its management. There is a standing committee of the board consisting of three members, designated the committee of trustees on the experiment station. This committee is required to visit the station each year and make a special report at the annual meeting of the board. No permanent improvement may be made without its approval. The general control of all the affairs of the station not exercised by the board is intrusted to a station council appointed or elected by that board and consisting at present of the president, director, heads of divisions, and associate chemist. No rules have been adopted by the board.

Canebrake Agricultural Experiment Station, Uniontown.

The Canebrake Agricultural Experiment Station is maintained exclusively by the State. The board of control consists of the commissioner of agriculture of the State, the director of the station, "and five cultivators of Canebrake land." The director of the station at Auburn is by law director ex officio of the Canebrake Station. The resident members of the staff are an assistant director in charge, veterinarian, and treasurer.

Tuskegee Agricultural Experiment Station, Tuskegee.

The Tuskegee Agricultural Experiment Station is managed by a board of control consisting of the State commissioner of agriculture, the president of the Alabama Polytechnic Institute, the director of the experiment station at Auburn, and the members of the board of trustees of the Tuskegee Normal and Industrial Institute who reside in the town of Tuskegee. Immediate oversight of station affairs is exercised through an executive committee of the board of control. A State law provides, "That the board of control must cause such experiments to be made at said station as will advance the interest of scientific agriculture, and to cause such chemical analyses to be made as are deemed necessary, all analyses, if requested, to be under the supervision of the commissioner of agriculture, by the chemist of the agricultural department, without charge."

ALASKA.

Alaska Agricultural Experiment Stations, Sitka, Kenai, and Copper Center.

Under the supervision of A. C. True, Director, Office of Experiment Stations,
United States Department of Agriculture.

The Alaska Experiment Stations are under the direct control of the Secretary of Agriculture, who manages them through the Office of Experiment Stations, the Director of which exercises general supervision of this enterprise. The immediate management of these stations is committed to a special agent in charge.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, Tucson.

Department of the University of Arizona.

The governing board of the Arizona Station consists of the governor of the Territory and the superintendent of public instruction ex officio and four members appointed by the governor for an indefinite term. The governor also has the power of removal of members. Board meetings are held twice a month. No system of rules regulating the conduct of station officials has been adopted. The director is given full charge of station affairs and is held responsible for results. Matters requiring the formal approval of the board are submitted at the regular meetings.

ARKANSAS.

Arkansas Agricultural Experiment Station, Fayetteville.

Department of the University of Arkansas.

The governing board of the Arkansas Station is the board of trustees of the university, which is composed of the governor of the State (chairman ex officio) and six members, one from each Congressional district, appointed by the governor, with the consent of the senate, for a term of six years. The board has entire management of the station in regard to salaries, appointment of officers, and important expenditures. Immediate oversight of the station is intrusted to a committee of the board, consisting of three members. The trustees are required by law to hold one meeting at the university and as many special meetings as may be necessary. No rules or regulations pertaining directly to the experiment station have been adopted. Appointments are made by the trustees for a term of one year. The director has general supervision of station affairs. He is required to report annually through the president to the trustees on the condition of the station, the experiments in progress and completed during the year, and proposed new work. Each head of division selects his own line of work, subject to the approval of the director and board of control.

CALIFORNIA.

Agricultural Experiment Station of the University of California, Berkeley.

Department of the University of California.

The California Experiment Station is under the management of the board of trustees of the university which consists of the governor of the State (president of the board), lieutenant-governor, the speaker of the assembly, and the State superintendent of public instruction, as ex officio members, and 16 members appointed by the governor, with the approval of the senate, for terms of sixteen years. Meetings are usually held monthly or more frequently. No formal code of rules has been adopted.

by the board. Up to the present year the work was practically under the direction of the director, the regents and president of the university taking no cognizance of the details, but only of the success of the work by the people of the State. Now, however, there are fortnightly meetings of the station staff presided over by the director, in which the station policy and expenditures, as well as the work to be done, are generally discussed and decided upon, especially as to the apportionment of funds.

COLORADO.

Agricultural Experiment Station, Fort Collins.

Department of the State Agricultural College of Colorado.

The governing board of the Colorado Station is the State board of agriculture, which consists of eight members appointed by the governor and confirmed by the State senate, with the governor of the State and the president of the college *ex officio*. The term of office is eight years. Two members are appointed biennially. If vacancies occur before the term of office expires they are filled by the remaining members. There are a number of standing committees, but these committees do not have the authority of the board except by special authorization. The most important committee is the executive committee, consisting of five members selected by ballot for two years, which was formed especially to supervise the affairs of the experiment station. This committee meets monthly and audits the expenditures of both experiment station and college. The board holds two meetings annually, one in December and one in June. Other meetings may be called by the president of the board at the request of three members. Regulations governing the future action of the board and staff were adopted in December, 1899, as follows:

REGULATIONS OF THE STATE BOARD OF AGRICULTURE GOVERNING THE EXPERIMENT STATION.

Resolved, That the following communication from the Director of Experiment Stations of the United States be spread on the records and adopted, as expressing the future policy of the board regarding the work and organization of the experiment station:

“U. S. DEPARTMENT OF AGRICULTURE,
“OFFICE OF EXPERIMENT STATIONS,
“Washington, D. C., August 19, 1899.

“Hon. P. F. SHARP,

“*President of the Board of Agriculture, Denver, Colo.*

“DEAR SIR: Referring to our recent conversation regarding the organization and work of the Colorado Experiment Station, it seems to me that the following points should especially engage the attention of the governing board in considering the reorganization of the station:

“(1) The station is, under the law, a department of the college, and as such should have an organization which will consolidate it and enable it to work as a unit. Experience shows that this can best be done by giving the station its own executive head (a director) and organizing a staff to work under his immediate direction.

“(2) The director should be made fully responsible for the planning and carrying out of the work of the station, for its expenditures and publications, and for the management of all business details, and he should be given ample authority for these purposes. The board should look to him for the initiative in all matters relating to the station, including the nomination of members of the staff, and should ordinarily confine itself to the appointment of the officers of the station and passing upon the plans for work and expenditures submitted by the director, through the president of the college, and auditing accounts. The director and other chief officers of the

station should be chosen to serve during good behavior and efficiency, and the plans of work and expenditures should be submitted to the board annually.

"(3) The members of the staff should be individually responsible to the director as regards station work, and should be held to the performance of work ordered by the director, which would often involve the cooperation of several members of the staff. As members of the station staff the professors should be distinctly subordinate to the director. In this respect they should hold a different position as regards station work from that which they hold as instructors in the college. Thus, the professor of chemistry is the head of the department of chemistry of the college, as far as instruction goes, and as such is subordinate only to the president of the college, but as chemist of the station he should act under the orders of the director.

"(4) The station council should be simply an advisory body, holding meetings for consultation on station interests, but voting, if at all, merely to express opinions.

"(5) The general plan of expenditures should be drawn up annually by the director after consultation with members of the staff and approved by the board. This should include estimates for salaries, expenses of the several departments, publications, etc. There should always be a certain reserve fund, to be spent at the discretion of the director, to meet emergencies arising during the year.

"Expenditures should be made on requisition drawn by the different members of the staff and approved by the director, and all bills should be approved before payment by the director. The accounts and vouchers for each year should be finally audited and indorsed by a committee of the governing board.

"(6) The main work of the station should be along one or two lines, and all members of the staff should cooperate in this work as far as practicable. This need not exclude smaller pieces of work in a few other lines, and it is well for each department to have some work in which it alone is concerned. In Colorado it seems natural and desirable that the station should concentrate its work on irrigation problems, and it should be a leading authority on these problems.

"Plans for the work should be carefully drawn up annually by the director, after consultation with members of the staff, and when approved by the board should be carried out carefully and vigorously. Careful attention should be given to the proper recording of work, and the station records should be preserved in fireproof safes or vaults.

"(7) All the work of the station, wherever conducted (whether at Fort Collins or in other localities in the State), should be under the immediate charge of the director, or such members of the staff as he may assign to have charge, and the director should be made responsible for the management of all work without regard to locality. Substations are not contemplated by the Hatch Act, and have generally proved very expensive and of little value, those in Colorado not being exceptions to the rule.

"The station should work for the general interests of the agriculture of Colorado, and should carry on its investigations wherever they can best be prosecuted, but should be free to move its field work from point to point as the requirements of the work may demand. It is not fair to the farmers of the State to maintain expensive substations in two or three favored localities. The amount of field work to be done at Fort Collins should be determined by the nature of the investigations pursued by the station at any time, and may be relatively small. If the station is organized to pursue a series of special investigations for the benefit of Colorado agriculture, there will be little difficulty in deciding where the work can best be done. The location of the work in any given instance should, of course, be left to the director and other expert officers of the station.

"I am not sure I have covered all the points you desired me to touch upon. I shall, of course, be glad to write you further at any time.

"Very respectfully yours,

"(Signed) A. C. TRUE."

Resolved, That in order to carry the foregoing recommendations into effect, the following regulations be adopted:

(1) That the experiment station shall be a department of the college (as provided by law), with the director as the responsible head. The heads of the sections, with the president of the college and the secretary of the State board of agriculture, shall constitute the advisory council to meet with the director from time to time for mutual consultation and consideration of station interests.

(2) Excepting for the year 1900, for which year the executive committee will act, in March, for the board, the director shall prepare and submit to the board, at its annual (December) meeting, after consultation with members of the staff, plans for the station work and estimates for the expenditures for the following year. After approval by the board it shall be the duty of the director to see that such plans are duly carried out, and thereafter such work, wherever carried on, shall be under his immediate charge or such member of the staff as he may assign to it.

(3) Expenditures from the funds under station control shall be on requisition signed by the director, and the bills approved by him before being audited by the executive committee and paid. In the absence of the director at or near the close of the month, some other member of the staff may be designated by him to act in his stead in this regard.

(4) Bulletins or other regular publications of the station shall be printed on the approval of the director and authorization of the executive committee. The printing of these shall be done, where possible, on contracts made by the director at the lowest figure obtainable on competitive bids for such work upon uniform specifications.

(5) That the director of the station be authorized and instructed to lease such portions of the lands now held by the State Agricultural College for experimental purposes as are not needed for scientific experimentation. Further, that such land shall be leased only on condition that the lessees thereof shall keep and report to the director a complete record of the sowing, irrigation, cultivation, and yield of the crops grown on such lands.

(6) Further, that the director be instructed to inaugurate and maintain throughout the station work a fundamental and comprehensive system of experimentation along the line of irrigation and irrigated agriculture without detriment or prejudice to investigations or experiments of the several sections on subjects directly concerning their departments of the station.

(7) All rules and regulations relating to the powers of the director or operation of the station which conflict with the above resolutions are repealed.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

The board of control consists of eight members, one appointed by the State agricultural society, one by the State board of agriculture, one by the board of trustees of the Wesleyan University, one by the governing board of the Sheffield Scientific School of Yale University, and two by the governor of Connecticut, with the advice and consent of the senate. These members serve for a term of three years. The governor of the State and the director of the station are also *ex-officio* members of the board of control. The board has general management of the institution and holds at least three meetings annually. More frequent meetings are held by the executive committee, which has adopted the following memorandum for the direction of the members of the station staff:

MEMORANDUM OF THE EXECUTIVE COMMITTEE OF THE BOARD OF CONTROL OF THE
CONNECTICUT AGRICULTURAL EXPERIMENT STATION.

Hitherto the duties of those in the employ of the station have been arranged verbally with each individual. The increase in the number of the staff and the gradual expansion of the work, as well as the further expansion which will follow the acceptance of the Lockwood trust funds, make necessary, in order to avoid all possible misunderstanding, what has long been considered by the executive committee, viz. a more precise statement of the duties of the station force.

The work of the station is carried on in four departments, named in the order of their establishment—the general laboratory, the botanical department, the laboratory for special research, and the horticultural and entomological department. * * *

While there are some investigations in which two or more of the departments cooperate, each is managed by its own head, under the general supervision of the director, without any interference from either of the other heads of departments. But it is expected that there will always be in future, as there has been in the past, a cordial cooperation between them to promote the usefulness of the station as a whole.

The chemists and others employed in each department are not responsible to the head of any department other than their own, unless by a special and temporary arrangement.

THE DUTIES OF HEADS OF DEPARTMENTS.

The duties are not confined to the mere performance of work which is planned for them by the director or which is sent in by the farmers of the State.

Such work is merely incidental and should be regarded as a necessary interruption. It is the duty of each head of a department to keep himself and the force of his department fully employed during all the working hours of every day with work which promises to be of value for the purposes for which this station is maintained. To this end each head of a department should plan special investigation and study, suggested by the special knowledge he has acquired, in which he is expert and by reason of which he has been chosen for his position, to be submitted for approval to the director.

THE DUTIES OF OTHERS OF THE STAFF.

The chemists and others employed in each department are to have their work assigned by the head of the department in which they are employed and are to do the work indicated by him.

THE STATION CLERK AND STENOGRAPHER

is responsible wholly to the director, and her work is to be prescribed by him. A moderate amount of writing for the several departments may generally be done by her through arrangement with the director.

She has entire care of the stationery, publications, and library, so far as the latter is in the general station office.

APPOINTMENTS.

The members of the station staff are chosen by the board of control, or by them through the executive committee, who also fix the salaries.

HOURS OF WORK.

The regular laboratory hours of work for the scientific staff are from 8.30 a. m. to 5 p. m. on every week day but Saturday, with an hour's intermission for lunch. On Saturday the working hours are from 8.30 a. m. to 12 m.

The hours may be changed in individual cases by arrangement with the director.

VACATIONS.

The scientific staff are entitled to one month's vacation in each year; that is; if they have been in the station employ for at least nine months; if for a less time, the vacation will be proportionately shortened.

The head of each department will take his vacation at such time as in his judgment his services can best be spared and with the approval of the director.

The others in each department will arrange the time for vacation with the head of the department in which they work, and in such way as to interfere as little as possible with the station work.

HOLIDAYS.

On the 1st day of January, the 12th and 22d of February, the 30th of May, the 4th of July, the 1st Monday in September, the 25th of December, and any day set apart by the governor or the President as a day of fasting or of thanksgiving, no work is expected of the station staff.

DISPOSITION OF FRUIT, VEGETABLES, FLOWERS, ETC.

With the exceptions hereinafter noted, the trees, vines, vegetables, flowers, shrubs, etc., growing out of doors are under the general care of Mr. Rice [in charge of stations and grounds]. The fruit, flowers, etc., are to be gathered by him alone and disposed of as ordered by the director.

(1) Plantings made by the horticulturist or botanist for purposes of observation and experiment, in places to be agreed upon with the director, are to be personally supervised by them and the necessary hand labor done by a workman under their direction. These plantings and their products, so far as they are required for the purpose of experiment, are to be under their sole control. Any excess is the property of the station.

(2) The horticulturist and botanist are to keep all trees and other plants at the station under supervision and, if disease or insect injury appears, to see that proper steps are taken to eradicate it.

(3) If any trees, shrubs, vines, etc., growing on the place are needed for experiment or observation, they may be taken for the purpose, with the consent of the director, who will see that they are not otherwise disturbed.

No trees are to be felled without approval of the executive committee.

The fruit, flowers, etc., grown for experimental purposes in the forcing houses, so far as they are not needed for purposes of experiment, are to be disposed of by the horticulturist, with the advice of the director.

PUBLICATIONS.

The head of each department, until otherwise ordered, will prepare for publication in the station reports the work of his department at such times as may be agreed upon, except such part as may be covered by papers written by others in the same department, by special arrangement with the head of the department and the director.

The writer is in every case responsible for the accuracy and completeness of the papers, and they must be so finished as to plan, style, and chirography that they may be sent to the printers without any editing by the station director.

The director will, however, when in his judgment it is desirable, make and suggest changes in the arrangement and presentation of the subject-matter to secure conciseness, accuracy, and uniformity.

If changes are made, opportunity will always be given before printing for the discussion of them with the writer.

The work done in station hours is the property of the station and, as a rule, should

first be described in station publications, but by agreement with the director this rule may be suspended when desirable.

It is the aim of the station in its published work to give full and exact credit to each employee.

Where two or more departments have necessarily been engaged in one piece of work, or where the general plan of the investigation has been mainly the work of one, but the execution of all the details has been the work of one or two others, it is extremely difficult to credit the work in a way that does exact justice to all. Any suggestions from the working force regarding the matter will be gladly received.

LIBRARY.

Current scientific journals are to be recorded by the clerk before they are taken from the offices.

When bound books or journals are taken from the library the title and the name of the borrower are to be entered in a book kept for the purpose by the clerk, and until returned to the clerk and by her canceled on the book the borrower is responsible for it.

Bulletins or reports in the station file must not be taken from the library under any consideration without permission of the director.

Storrs Agricultural Experiment Station, Storrs.

Department of the Connecticut Agricultural College.

The Storrs Station is under the control of the board of trustees of the college, which consists of six members elected by the State senate for terms of four years, one member elected annually by the State board of agriculture, one member, a graduate of the college, elected by the alumni, and the director of the State Station at New Haven ex officio. The governor of the State is ex-officio president of the board. This board meets annually, and its duties are those of general supervision and control of finances. The more direct management of station affairs is delegated by the board to the executive committee, consisting of two of its members and the president of the college. This committee places the work of the station in charge of the director, upon whom rests the responsibility for the management in detail. All members of the station staff report to the director with reference to station work, and those who are employed by the experiment station are responsible only to the director for the performance of their duties.

DELAWARE.

The Delaware College Agricultural Experiment Station, Newark.

Department of Delaware College.

The governing board of the station is the board of trustees of the college, which consists of 32 members, 15 of whom represent an original body which managed Delaware College prior to the passage of the first act of Congress establishing land-grant colleges. Upon the acceptance of that grant by the State, a second board of 15 members was created, which was appointed by the governor of the State. To these 30 members, the governor of the State and the president of the college have been added as ex-officio members. The original board has power to fill vacancies in its membership. The governor fills vacancies in the State board by appointment. Immediate oversight of the station is delegated to a committee on agriculture, consisting of 5 members. Two stated board meetings are held annually. At the meeting held June 15, 1903, the board adopted the following regulations:

REGULATIONS OF DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION.

(1) That the experiment station shall be known and designated as a department of the college.

(2) The ruling authority over said department shall be by a governing board, which said governing board shall be composed of the president of the college, who shall preside at all meetings of said board, the director of the station, the professor of agriculture in the college, who shall be secretary of said board, the treasurer of the board of trustees of the college, and the members of the committee of agriculture of the trustees.

The governing board shall have the power to recommend to the [board of] trustees the names of persons to be elected as heads of the various departments of the experiment station, and the assistants to said heads of departments, and, if authorized by resolution of the board [of trustees], to fix the salaries to be paid to such persons, and also to recommend to the said board the dismissal of the head of any department or any assistant thereto.

The governing board shall have the power of appointing members of the station staff or their assistants if vacancies occur at any time when the board of trustees is not in session. The names of persons so appointed, however, to be submitted for the approval of the board at the next meeting thereof.

The governing board shall recommend to the board of trustees the course of studies in the agricultural department of the college, and shall determine the line of investigation and research to be pursued by the experiment station. The said governing board shall make allotment of funds to be applied to the work of investigation and research undertaken by the experiment station, and the fund to be applied to printing, purchase of apparatus, books, and journals, etc., and shall make an equitable apportionment of the salaries between the college fund and the station fund, according to the work done on behalf of the college and station by those persons who may be assigned to duties in both the station and the college.

The governing board shall hold regular meetings in the months of March, June, and September, and shall meet at such other times as the president shall call them together for the transaction of business that may need attention, and report the same to the board of trustees at their next meeting.

The station staff, one of whom shall be designated by the board of trustees as the director of the station, shall be as follows: (1) Agriculturist; (2) mycologist and bacteriologist; (3) chemist, and (4) horticulturist.

In addition to the foregoing, there shall be an entomologist, who shall be an assistant to the horticulturist, and there shall also be an assistant to the mycologist and bacteriologist, a meteorologist as an assistant, and such other assistants as the governing board may from time to time recommend and be authorized by the board of trustees.

DIRECTOR.

The director of the station shall be responsible to the governing board for execution of the general policy and conduct of the work of the station. He shall have charge of the distribution and disbursement of the funds to be applied to the work of investigation and research, printing, purchase of apparatus, books and journals, etc. He shall appoint and have authority over all persons appointed as janitors or laborers in connection with the experiment station, and, in contemplation of absence from the station or disability, shall designate some member of the station staff to exercise authority over such persons. He shall have the approval of all bills presented for payment out of the State funds. He shall have charge of the official correspondence of the station. He shall have charge of all interests not specifically assigned to other members of the station staff. He shall annually make, through the president of the college, at the March meeting of the board of trustees, a full and complete report of the work of the experiment station for the preceding year.

The other members of the station staff shall perform all those duties that properly appertain to their respective departments, and such other duties as may from time to time be assigned to them by the director of the station, and shall annually report in writing the result of their investigation and research to the director of the station.

The members of the station staff shall meet in conference at least once each month, at which conference there shall be a consultation between the members of the station staff concerning the work of their respective departments and the general policy pursued by the station.

There shall be a record of the proceedings of the conference kept by the secretary, who shall be the professor of agriculture in the college.

All questions of dispute between the director and any member of the staff, or between any members of the staff, shall be heard and determined by the governing board. * * *

FLORIDA.

Agricultural Experiment Station of Florida, *Lake City.*

Department of the University of Florida.

The Florida Station is under the control of the board of trustees of the university, which consists of seven members, appointed by the governor for terms of four years and confirmed by the State senate. Not more than two members may belong to the county in which the college and station are located. Meetings of the board are held at the call of the president of the board. No printed rules or regulations have been adopted for the guidance of the board or for the station staff. The duties of the director are chiefly administrative. He edits and publishes the bulletins and reports and has general supervision of all the work of the station.

GEORGIA.

Georgia Experiment Station, *Experiment.^a*

Department of Georgia State College of Agriculture and Mechanic Arts.

The governing authority of the Georgia Station is vested in a board of directors, which is composed of the commissioner of agriculture of Georgia (who is ex-officio president of the board), the chancellor of the State University, ex officio, one member of the faculty of the State College appointed by the governor each year, and one "practical and successful" farmer from each Congressional district in the State, appointed by the governor for a term of five years. A standing executive committee of three members is charged with the duty of auditing and approving requisitions of the director for funds for ordinary expenses, and, in general, exercises the authority of the board when that body is not in session. The rules and regulations adopted May 11, 1892, for the internal government of the station, are as follows:

RULES OF THE GEORGIA EXPERIMENT STATION.

(1) The buildings, grounds, machinery and tools, and live stock are assigned to the care and control of the several officers, as follows:

(2) *The Agriculturist* will have general charge of the barn and stable building, the ginnery, and the area in front and rear of these two buildings; and special charge of the horse stable and hallway, the stable office, the attic, and all the second floor excepting two rooms; all horses and mules while in stable or yard; the tobacco barn; the ornamental grounds south of and including the office avenue; the woodland and

^aTelegraph, freight, and express address, *Griffin.*

the pasture lands, and the agricultural divisions of the farm, including the sidewalks adjacent.

(3) *The Horticulturist* is charged with the control and care of the horticultural divisions of the farm, and the ornamental grounds and lawns north of the office avenue; all the greenhouses, the seed house, and two rooms on the second floor of the barn.

(4) *The Dairyman* is charged with the care and control of the cattle, cattle stable and grounds, the dairy, the pigs and yard, and all appurtenances.

(5) *The Assistant Chemist* is charged with the control of the laboratory building and apparatus and the immediate surroundings; the waterworks, gas works, meteorological instruments and records.

(6) *All buildings, machinery, tools, wagons, harness, etc.*, must be kept in as good order as may consist with frequency of use by officers in charge. Heavy plows and harrows may be left in the furrow overnight when their use is to be continued in the same place the next morning; otherwise they must be brought under cover and properly cleaned.

(7) *The entire stable department* and the dairy must be in perfect inspection order at least once a day, and all other buildings and property will be subject to inspection every Saturday at 12 m.

(8) *Farm labor* will commence daily at sunrise and cease at sunset. From May 1 to August 31 an intermission of one and one-half hours, and from September 1 to April 30 one hour will be observed, commencing at 12 m.; the bell to be sounded by the agriculturist.

(9) *Ordinary farm labor* will be suspended at 12 m. Saturdays until Monday mornings, but all laborers will be engaged with the express understanding that they will labor Saturday afternoons or out of hours on any day in case of emergency.

(10) *Laborers* will be held responsible for damage to or loss of tools, etc., otherwise than that resulting from reasonable wear and tear, and for loss of time involved in looking for misplaced tools, to be charged on the weekly pay roll.

(11) *Pay rolls* of employees and laborers will be made out weekly by officers in charge, approved by the director, and paid by the accountant at noon each Saturday.

(12) *Requisitions* for all supplies and repairs required in each department of the station must be made out in detail on printed blanks by the officers in charge, approved by the director (except in case of emergency), and such officer to retain a copy of the order and verify the delivery. The original order must be returned with the bill for payment, indorsed "correct" by the officer ordering, and "ordered paid" by the director.

(13) *The products* of the farm sold to officers, employees, and laborers must be reported by bill to the accountant by the officer selling the same; the price to be fixed by said officer, subject to the approval of the director. The accountant will present and collect bills due by officers monthly and those owed by employees and laborers weekly.

(14) *The labor* of the station must not be diverted to the private benefit of officers during working hours.

(15) *All persons* (excepting officers and adult members of their families, employees, and laborers in the discharge of their duties) are positively forbidden to enter upon, or pass through the farm, or any portion thereof, whether inclosed or uninclosed—not a residence, unless by express permission in each case. Visitors to the station will be requested to call at the office and register, and they will be shown over the farm and through the buildings by one of the officers. Each officer is expected to enforce this rule, especially in his own department, as occasion may demand.

(16) *Hunting* with dog or gun or otherwise, and the discharge of firearms, on any portion of the station premises is absolutely forbidden.

(17) *Officers* will not absent themselves from the station premises during business hours without the approval of the director, except in case of emergency.

AMENDMENTS.

From and after this date (January 1, 1895) the feeding, grooming, and general care of all horses and mules will be under the control and direction of the dairyman, including the care of the entire stable floor of the barn.

HAWAIIAN ISLANDS.

Hawaii Agricultural Experiment Station, Honolulu.

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

The act of Congress approved March 2, 1901, making appropriations for the Department of Agriculture, provided for the establishment and maintenance of an experiment station in Hawaii, to be under the control of the Secretary of Agriculture, who manages the station through the Office of Experiment Stations, the Director of which has general supervision of this enterprise. The immediate management of this station is under the special agent in charge.

IDAHO.

Agricultural Experiment Station of the University of Idaho, Moscow.

Department of the University of Idaho.

The Idaho Station is under the control of a board of regents of the university, which consists of nine members, appointed by the governor of the State and confirmed by the senate for terms of six years. The duties of the board of regents are to appoint the director and other members of the station staff and to supervise the operations of the station in a general way. The board of regents meets once a year. In the intervals between board meetings matters of minor importance are considered and passed upon by a resident executive committee consisting of three members of the board, which holds monthly meetings. The director is the executive officer of the staff. All plans of work must receive his approval before being carried into execution. There is a station council, consisting of the director and heads of divisions, which meets monthly to discuss and pass upon lines of work proposed or under way. The board of regents has not adopted a code of rules, but has approved the following set of rules adopted by the station council:

STATION COUNCIL.

In accordance with the ruling of the regents the station council shall consist of the staff, as shown in this report or as may be modified hereafter by the regents.

OBJECT.

The province of the station council is to be advisory only as to the various lines of scientific investigation to be carried on in the State, as determined by existing conditions, from time to time; also to hear and discuss such papers and reports as may be thought best to present to it for the information of the members.

OFFICERS OF THE COUNCIL.

- (1) The officers of the council shall be a chairman and a secretary.
- (2) The director of the experiment station shall be the chairman. In his absence the senior professor in the university faculty shall be acting director and chairman.
- (3) The council shall elect a secretary, and in his absence the chairman may appoint a secretary pro tem.

MEETINGS.

Regular meetings of the council shall be held on the first Monday afternoon of each month not occupied by the faculty. Special meetings may be held at the call of the director.

REPORTS.

(1) Each head of a department represented in the council shall submit to the director, not later than May 15 of each year, an outline of the proposed work of his department for the ensuing year, together with the approximate cost for the performance of the same; also such budgets for supplies as he may need for the ensuing year. When such reports, estimates, and budgets shall have been approved by the director and regents, the same shall become operative.

(2) The annual reports of the departments to the director for publication shall be submitted not later than July 1.

(3) The annual report of the station shall be issued July 1 of each year. It shall contain, in addition to the usual financial statement and the report of the director, a summary of the work of each department for the preceding fiscal year; also such additional matter as may be valuable for publication, but of so miscellaneous a character and meager in quantity as not to make a regular bulletin of the department.

(4) The regular bulletins of the station shall be paged continuously for the fiscal year covered by them.

(5) All press bulletins shall be of uniform style and size, as No. 11.

(6) Regular bulletins shall be in size 6 by 9 inches, and the form and arrangement of the Cornell Station bulletin shall be adopted for the first two pages, and our officers and staff shall be arranged as shown in the following pages. * * *

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, *Urbana*.

Department of the University of Illinois.

The Illinois Station is regarded as coordinate in rank with the agricultural college rather than a department of it, that is, the experiment station is regarded as a department of the university rather than of the college. The governing board of the station is the board of trustees of the university, which consists of the governor of the State, the president of the State board of agriculture, and the superintendent of public instruction, ex officio, and 9 members elected by the people, 3 at each biennial election, for a period of six years. The duties of this board are those of trustees, to administer funds as appropriated and directed by Congress and the State legislature. Immediate supervision of station affairs is delegated to a committee of 4 of the board of trustees, known as the committee on agriculture. The director of the station is responsible for the conduct of the work and makes all reports, together with recommendations as to employees to the board of trustees through the president of the university. Action is ordinarily taken upon his recommendation, although a matter might arise upon the recommendation of the advisory board or of the president of the university.

The work of the station is carried by five departments, namely: Agronomy, chemistry, animal husbandry, dairying, and horticulture and botany. The head of each department is held absolutely responsible for money intrusted to him, and little restraint is placed on his freedom of action, but he is held strictly accountable for results. He is charged with the duty of reporting regularly to his superior officer and may be called upon at any time to report upon any feature of the work in hand.

The funds appropriated by the State for special investigations are managed in

precisely the same way, excepting that funds are appropriated for specified purposes, and the use of each fund is along the lines agreed upon by the director and the advisory committee appointed by the association representing the interest—as, for example, the advisory committee appointed by the Live Stock Association to confer with the director regarding the live-stock investigations.

All reports are made to the director so far as United States funds are concerned, and to the advisory committee so far as State station funds are concerned.

INDIANA.

Agricultural Experiment Station of Indiana, Lafayette.

Department of Purdue University.

The governing board of the Indiana Experiment Station is the board of trustees of Purdue University, which consists of nine members appointed by the governor for a term of four years each. The board meets four times each year. Three of the trustees constitute a farm committee, which meets with the director or president, as circumstances require. The station staff meets at irregular intervals to consult upon important matters. All considerable expenditures of money must be made by the president and issued upon order. The board of trustees has no set rules, regulations, or by-laws. The director is given entire supervision of the station.

IOWA.

Iowa Agricultural Experiment Station, Ames.

Department of Iowa State College of Agriculture and Mechanic Arts.

The Iowa Station is governed by the board of trustees of the Iowa State College, which consists of the governor of the State and the superintendent of public instruction, ex officio, and eleven members, one from each Congressional district, elected by the State legislature for a period of six years. Meetings are held semiannually and oftener when necessary. A committee of the board, consisting of six members, has immediate charge of the experiment station and the agricultural, horticultural, and veterinary departments of the college. This committee, however, meets only as a committee of the board and at the time of its regular meeting, and any action taken by it is always referred to the board for approval. The rules of the station are as follows:

EXPERIMENT STATION RULES.

(1) The president of the college and the director of the station and the heads of the sections of agriculture, horticulture, agricultural chemistry, entomology, botany, veterinary science, animal husbandry, and dairying shall constitute a board of direction. The director shall be the executive officer of the station. The board of direction shall hold semiannual meetings two weeks previous to the June and December meetings of the board of trustees. Other meetings may be held at the call of the director of the station or the president of the college.

(2) The working staff of the station shall consist of the director of the station and the professors or the heads of the sections of agriculture, horticulture, agricultural chemistry, entomology, botany, veterinary science, animal husbandry, dairying, and their assistants.

(3) Competent assistants shall be employed in such sections of the station as require them, and when employed shall be under the control and direction of the head of the section to which they are respectively assigned. It shall be their duty to carry on the work assigned to them in the said section, and they shall receive due credit in the bulletin for the same.

(4) The plan of experimentation devised by the heads of sections and their working staff, and the estimated expense of conducting the same, shall be submitted to the director of the experiment station at least one week previous to the June meeting of the board of direction. The heads of the various sections of the station shall also at the same time submit to the director of the station an outline of all experimental work contemplated during the ensuing year, together with an estimate of the funds necessary to carry on such work and the compensation for same. In cases of emergency or when desirable to take up additional work during the year, the head of the section wishing to take up such work shall consult with the director and present an outline and the expense of such additional work for approval.

(5) If in the judgment of the director of the station the funds or any part of the funds, appropriated to any section are not needed for work contemplated, or are not being properly used, the director may refer the matter to the agricultural committee of the board for reapportionment of the funds.

(6) It shall be the duty of the heads of sections to recommend to the director of the experiment station, one week previous to the June meeting of the board of trustees, the number of assistants needed in his section, their compensation, and to recommend candidates for the positions.

(7) When it becomes necessary for any section of the station to have any additional scientific assistants, or in case of vacancies, and the work of the station may be delayed by waiting for the regular meeting of the board of trustees, such assistants may be selected by a committee consisting of the president of the college, the director of the station, and the head of the section for which such additional help is asked, their selection to be submitted to the board of trustees at its next meeting.

(8) The director of the experiment station shall submit to the board of trustees, through the president of the college at its annual meeting in June, an outline of the experimental work to be conducted by the several sections of the experiment station during the ensuing year and an estimate of the expense for the work of each section, and the general and incidental expenses, the number of assistants to be employed in each section, and the compensation for each. The director shall also report to the board of trustees all recommendations of the station board of direction and all other matters of direct interest concerning the work of the experiment station.

(9) The several sections of the station shall report the condition of experimental work in progress when called upon by the director of the station or the board of direction, and shall submit to the director of the station and the board of direction reports of such investigations when finished for publication in the station bulletins. These bulletins shall be published quarterly or oftener. Such reports of experiment station investigations shall be confined to original research matter, except in such cases as the director may see fit to make exceptions, but all material before being used in the bulletin shall be read before the board of direction for its approval.

(10) The duties of the director shall be advisory and executive. It shall be his duty to examine the work of each section so as to be advised personally of the character of the work done and in progress, and to revise and arrange such details as will make the whole experimental work uniform and conducive to the best results in experimental agriculture; and where two or more sections are at work jointly upon experiments or investigations it shall be his duty to see that they work in harmony, and, in case of any disputes, he shall be the final arbiter. He shall have charge of and conduct the general correspondence of the station, see to the publication and distribution of the bulletins, and perform such other duties as shall be assigned by the board of trustees. The director of the station shall approve and audit all bills to be paid from station funds. All action taken by the director of the station or the board of direction relating to the work and management of the experiment station shall be subject to the approval of the president of the college and the board of trustees.

(11) The experiment station shall use such land as shall be assigned to it by the board of trustees for experimental work.

(12) The board of trustees or the professor of agriculture shall assign such farm tools, machinery, stock, materials, labor, and teams for the use of the station as can be done without interfering with the college work in his department.

(13) The station library shall not be fitted up or equipped with station funds except by special vote of the board of trustees, but all purchases of books or periodicals for station use shall be purchased in the usual way, through the college library.

KANSAS.

Kansas Agricultural Experiment Station, *Manhattan.*

Department of Kansas State Agricultural College.

The Kansas Station is under the control of the board of regents of the agricultural college, which consists of seven members, appointed by the governor and confirmed by the State senate for terms of four years. The affairs of the station are managed by a council in accordance with the following resolutions adopted by the board of regents January 18, 1900:

The experiment station shall be managed by a council, to consist of the president of the college, who shall be chairman *ex officio*, an agriculturist, a botanist, a chemist, an entomologist and horticulturist, a veterinarian, and such others as the board of regents may designate. A member of the council, named by the board, shall be styled director. He shall be the executive officer of the station, and as such shall attend to its general business and correspondence, the printing, binding, and distribution of its publications, and such other matters as the board or council may direct, but in all things shall be subject to the action of the council. All experiments shall be undertaken with the advice and consent of the council, but the details of their performance shall be under the control of the departments in charge of them, respectively. The council shall hold regular monthly meetings, and such special meetings as may be necessary.

The plans for managing the substation at the Fort Hays Reservation are shown in the following resolutions adopted by the board of regents December 13, 1901:

Resolved, That the president of the board of regents shall appoint a regent, who shall, under the direction of the board, have special charge of all matters pertaining to the Fort Hays Reservation in behalf of the agricultural college, the experiment station council to direct all experiments, subject to the approval of the board.

Resolved, That the crop experiments and such other experiments as can be provided for be begun in the year 1902 on as liberal a scale as circumstances and the funds at our command permit, and that all seeding, cultivation, harvesting, storing, sale, and purchase of commodities, or of live stock and its feeding, pertaining to experimental work, and all records in reference thereto be under the immediate supervision and direction of a competent man, who shall be stationed at Hays so much of the time as may be necessary for best doing the work contemplated.

Resolved, That such repairs be made upon the buildings on the Fort Hays Reservation as shall make them available for use, and that a practical farmer be employed, who shall be known as foreman of the farm, and who shall see that all contracts pertaining thereto are fulfilled and all property belonging to the experiment station be properly cared for, and shall perform such other duties as shall be assigned to him.

Resolved, That the regent appointed to have charge of the interests of the experiment station at Hays shall be paid his per diem and actual and necessary expenses incurred in the performance of such duties, but shall not be allowed mileage.

KENTUCKY.

Kentucky Agricultural Experiment Station, Lexington.

Department of the Agricultural and Mechanical College of Kentucky.

The governing board of the Kentucky Station is the board of trustees of the college, and president of the college, ex officio, and 15 members appointed by the governor for terms of six years. The board of trustees appoints a committee, called the board of control. It consists of three members of the board of trustees, the president of the college, and the director of the station. It elects a chairman and secretary, and appoints from its members a finance committee, which supervises the expenditures of the station, meeting for this purpose bimonthly. Neither the board of trustees nor the board of control has adopted rules governing the station. The director plans the work and the experiments to be undertaken, attends to the correspondence, and has general supervision of station affairs.

LOUISIANA.

No. 1. Sugar Experiment Station, Audubon Park, New Orleans.

No. 2. State Experiment Station, Baton Rouge.

No. 3. North Louisiana Experiment Station, Calhoun.

Department of Louisiana State University and Agricultural and Mechanical College.

The State of Louisiana has a system of three experiment stations, all coordinate in rank and under the same directorship. One is located at Audubon Park, New Orleans, and is known as Sugar Experiment Station, No. 1; the second is at Baton Rouge, and is known as the State Experiment Station, No. 2; the third is at Calhoun, and is known as the North Louisiana Experiment Station, No. 3.

The three stations constitute a department of the Louisiana State University and Agricultural and Mechanical College. The governing board of all the stations is the Louisiana State Bureau of Agriculture and Immigration, which consists of the governor of the State, the vice-president of the board of supervisors of the Agricultural and Mechanical College, the commissioner of agriculture and immigration, the president of the State University, and the director of the State experiment station ex officio, and six members appointed by the governor for terms of six years. This board meets on the call of the governor. The president of the college is ex officio a member of each of the station staffs, and the same person is director of all the stations. Members subordinate to him are appointed by him, by and with the consent of the governing board, and hold office during good behavior. The duties of the director are the control of the three stations, and he distributes, as occasion demands, lines of work to the different members of the staff. No special code of rules has been adopted by the bureau. The record of the proceedings of each regular meeting of the bureau serves for the guidance of the station officials.

MAINE.

Maine Agricultural Experiment Station, Orono.

Department of University of Maine.

The governing board of the Maine Experiment Station is the board of trustees of the university. The immediate management is delegated to a station council, consisting of the president of the university, the director of the station, heads of divisions, three members from the board of trustees, and one member each of the State board of agriculture, State Grange, State Pomological Society, and the State Dairymen's

Association. The station council meets once a year, and its recommendations are referred to the trustees for ratification. Appointments to the station staff are made by the board of trustees on the recommendation of the director and president, assistants usually for a definite period of time, and heads of divisions for indefinite periods. At the annual meeting of the station council the director reviews the work which has been undertaken for the past year and makes recommendations for the following year. The director is charged with carrying out the plans of work approved by the council, and, in general, acts as the executive officer of the station. No formal rules have been adopted by the trustees.

MARYLAND.

Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College.

The Maryland college is a combined State and stockholder institution, and, with its experiment station, is governed by a board of trustees, which consists of the governor of the State, the president of the senate, the speaker of the house of delegates, attorney-general, State treasurer and comptroller, ex officio, 6 members appointed by the governor of the State, 1 from each Congressional district, for terms of six years, and 5 members elected by the stockholders and serving for one year, or until their successors are elected. The governor of the State is ex-officio president of the board. The entire board of trustees elect officers and fix salaries, but all other expenditures are directed by a station committee, consisting of 5 members of the board appointed by the governor for a term of one year. The following by-laws of the corporation contain the only regulations adopted for the conduct of station affairs:

MARYLAND AGRICULTURAL COLLEGE.

BY-LAWS OF THE CORPORATION.

(1) Stated meetings of the trustees shall be held at the college on the second Friday in the months of June, October, December, and March, and the registrar shall give at least ten days' notice thereof, in writing, to each of the trustees. Five members shall constitute a quorum as prescribed by the charter.

(2) Special meetings may be called at any time and place that may be deemed expedient by the president of the board, or three of the trustees, and the object of every called meeting shall be stated in the notices sent to the trustees. Any meeting may be adjourned to meet again at any time and place that the majority present shall decide, except that the regular quarterly meeting shall be held at the college.

* * * * *

(9) The voice of the majority of all the members—viz, nine—of the board of trustees shall be necessary for disposing of money or other property belonging to the college and experiment station exceeding \$500 in amount or value, also for the election or removal of any officer or professor of the institution, including the experiment station, or for reversing any action of the faculty in cases of discipline appealed to the board of trustees.

(10) No money shall be expended and no debt contracted in the name of the college or experiment station not approved at a meeting of the board of trustees.

* * * * *

(12) The president of the faculty shall be an honorary member of the board of trustees, and be invited to be present at their meetings, and also at all stated meetings of the standing committees of the board, and any officer or professor shall be permitted to attend any meeting of the trustees, held at the college, for the purpose of directing their attention to any business in which he may be personally interested.

(13) All action of the board of a personal character shall be subject to the same regulations which control legislative bodies in executive session.

(14) The board of trustees shall have power to rescind any appointment, upon giving two months' notice to the incumbent, and the salary shall cease with the close of the service.

(15) All professors or officers wishing to close their connection with the college or station shall give at least two months' notice of such intention to the president of the faculty or director of the station, to be transmitted to the president of the board of trustees.

(16) The salaries of officers and all employees are paid on the last day of each month, in full, for services rendered to date. The fiscal year commences July 1.

* * * * *

(19) All reports to the board of trustees, or other authorities, by the different departments of the college shall be transmitted through the president to those bodies, except the report of the director of the experiment station.

(20) It shall require the votes of a majority of the entire board of trustees to alter, amend, or abolish any one of the foregoing by-laws, and all by-laws, rules, and regulations inconsistent therewith are hereby repealed.

DUTIES OF THE PRESIDENT.

(21) The president of the faculty shall be the chief executive officer to carry into effect the rules and regulations of the board of trustees, and the general superintendence and government of the college shall be committed to him. He shall have authority to visit the various schools and departments, and report the result of his observations to the board of trustees. He shall have control over the college buildings, grounds, farm, etc., shall inspect all drafts upon the registrar for money or supplies, which shall, before being paid, be approved and indorsed by him. * * * He shall make a report to the board of trustees, at their regular quarterly meetings, upon the general condition of the institution. * * * He shall, at the quarterly meeting of the board nearest to the close of the college year, submit estimates of the income of the college and experiment station for the next year, and also of the sums necessary for the expenditures in the different departments of the college and experiment station. These estimates may be considered by the board or referred to the finance committee for assistance in making the annual appropriations.

(22) The president of the faculty, if also director of the experiment station, and the director, if another person, shall perform similar duties and have similar powers with the experiment station as prescribed for the president in connection with the college.

(23) All officers and employees of the college and station not appointed by the board of trustees or its executive committee shall be appointed by the president, subject to the approval of the executive committee. * * *

DUTIES OF THE REGISTRAR.

(24) The registrar of the college shall be elected annually, and shall be removable from office at the pleasure of the trustees, as officers are. * * * He shall also act as secretary to the board and treasurer of the institution.

He shall reside at or near the college and keep an accurate account of his receipts and disbursements, making reports, when required, of the same, in detail, with vouchers, to the president and to the board of trustees, at the regular quarterly meetings, and whenever required, showing the working and expense of each department.

He shall give bond in some bonding company in the sum of ten thousand dollars (\$10,000), to be approved by the president of the board of trustees, for the faithful

performance of his duties. His books shall at all times be subject to the inspection of the president and trustees of the college. The funds of the college shall be deposited in such bank as the trustees shall direct. * * *

(26) No professor or other officer shall engage in any other occupation without special permission from the board of trustees.

(27) No professor or other officer shall absent himself from the college for a longer period than ten days, without the permission of the executive committee, nor for any less period, which interferes with the discharge of his special duties, or his share in the general management, without the permission of the president.

(28) Professors and other officers shall have charge and be held responsible for the instruments, apparatus, and books supplied for the use of their respective departments, and will be required to preserve them from all unnecessary injury.

(29) An annual inventory shall be made by officers or professors designated by the president of all instruments, apparatus, books, stock implements, furnitures, stores and supplies of every nature, belonging to the college and experiment station.

MASSACHUSETTS.

Hatch Experiment Station of the Massachusetts Agricultural College,
Amherst.

Department of the Massachusetts Agricultural College.

The governing board of the Massachusetts Station is the board of trustees of the college. The members of the board are appointed by the governor of the State, but the alumni of the college exercise the right of recommendation of candidates, and their recommendation has great weight. The board consists of 14 members by appointment, and the governor, the president of the college, the secretary of the State board of education, and the secretary of the State board of agriculture, ex officio. The members by appointment hold office for seven years, two members of the board retiring each year. The duties of the board are to determine the disposition of funds, to elect experiment-station workers, etc. The only committee of the board brought into special relation with the station is the committee on the experiment department, consisting of five members. This committee is consulted with regard to the experimental work which the heads of the divisions purpose to undertake, and must give its approval to their plans before the work is entered upon. The committee, moreover, has the right to suggest experimental work. As a matter of fact, this right has been but little exercised, and the approval of plans has been merely formal for the most part. It meets regularly at the close of each quarter. The full board of trustees meets regularly twice annually. It may be called together at other times whenever there is special business demanding attention. Members of the staff are appointed by the board of trustees and hold office as long as their services are satisfactory. The duties of the director are almost exclusively executive, although he may suggest lines of investigation. The by-laws of the station are not in such shape as to be available for publication.

MICHIGAN.

Experiment Station of Michigan Agricultural College, Agricultural College.^a

Department of Michigan Agricultural College.

The governing board of the Michigan Agricultural College, with its experiment station, is the State board of agriculture, which consists of the governor of the State

^a Freight and express address, *Lansing.*

and the president of the college, ex officio, and six members appointed by the governor for terms of six years. The officers of the board are a president, elected from its members, and a secretary and a treasurer appointed by the board. The president of the board is ex-officio member of each of its standing committees, of which one on experiments, consisting of two members, has immediate oversight of the station.

The executive of the station is the director who reports through the president to the board of agriculture. Associated with the director is a council called together at infrequent and irregular intervals, at the option of the director, to consider such matters as he may bring before it. Invariably once each year all the workers in the station are called together and the director reports as to all the experiments going forward in the station, so that each member of the staff is informed as to the work and is able to explain to farmers or others with whom he comes in contact just what the station is doing. This council consists of the president of the college, secretary of the board, and the station director, horticulturist, bacteriologist, entomologist, and experimenter with live stock. It has legislative power to a certain degree and is above all the advisory council of the director. The board of agriculture has never interfered with the experiments of the station nor indicated the policy to be followed.

The money coming from the General Government is expended by requisition signed by the director if over \$5, or by the head of the department if for smaller sums. An allotment is made annually to each department for funds for running expenses, although as a matter of fact the director and the head of each department are in constant consultation.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of University of Minnesota.

The State delegates the government of the station to the board of regents of the university, which body supplements the funds accruing from the National appropriations with others from its own current expense fund. The State legislature provides special funds for buildings and for the equipment and support of the substations. The board of regents of the university consists of the governor of the State, the superintendent of public instruction, and the president of the university, ex officio, and nine members appointed by the governor for terms of six years each.

The agricultural department, including the experiment station, the college of agriculture, and the school of agriculture, is governed by the board of regents. Of this board there is an agricultural committee of five, to whom the director submits a full report of the work of each division under his direction. On the 1st of April of each year the report of this committee is submitted to the board of regents, and on its approval the director is authorized to expend the estimated amounts allowed largely as he deems best, keeping, of course, in close touch with his agricultural committee. The bills are audited by the executive committee of the board of regents. There are no rules or regulations laid down as to the government of the institution.

The director is the executive head of the staff and is the medium of communication between members of the staff and the governing board, of which he is a member. He has full consulting and advisory powers with all the heads of divisions, and to them he distributes and delegates the technical research work and the publishing of reports of the experiment stations.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.*^a

Department of Mississippi Agricultural and Mechanical College.

The Mississippi Station is under the management of the board of trustees, of which the governor of the State is ex-officio chairman, and the president of the college. Immediate oversight of the station is entrusted to a governing board, consisting of the local members of the board of trustees, the president of the college, and the director of the station. The president and the director constitute the governing board and are the only members who pass upon the work relating to the station. The director prepares the outlines of the work, these outlines being signed by the director and other officers concerned, and submitted to the president for approval. Once a year, at a meeting of the board during commencement week, certain matters concerning new lines of work, the fixing of salaries, etc., are presented to them for consideration. The annual report of the station is also submitted to them at this time, but no outline of proposed investigations is presented for their consideration. No definite code of rules has been adopted by the board of trustees for the government of the station.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

The control of the station is vested in the board of curators of the university, which consists of nine members, appointed by the governor from different political parties for periods of six years. The term of office of one-third of the board expires every two years. Meetings are held twice a year. In the intervals between board meetings the immediate oversight of station affairs is delegated to an executive committee of the board, consisting of three members, who hold monthly meetings. The Missouri State board of agriculture is an advisory council, the duties of which are to examine into the work and management of the station and suggest to the board of curators of the university lines of experimental work.

The director is responsible to the president and board for the policy, management, and success of the station in all its departments. The station council, consisting of the chief officers of the station, the director, and the president, meets once each year and recommends to the board a tentative distribution of the station funds among the different divisions of the station and the lines of experimental work that should be carried on during the ensuing year. The rules of the station are undergoing revision.

Missouri State Fruit Experiment Station, *Mountain Grove.*

This station is under the control of a board of trustees consisting of three members. This board has not adopted a system of rules or regulations for the guidance of the station officers.

MONTANA.

Montana Agricultural Experiment Station, *Bozeman.*

Department of the Montana College of Agriculture and Mechanic Arts.

Both college and station are under the general supervision of the State board of education, the members of which are nominated by the governor and confirmed by the State senate. Immediate control of these institutions is delegated to an execu-

^aTelegraph address, *Starkville.*

five board appointed for four years by the governor, with the consent of the board of education, and consisting of five members, at least three of whom must be residents of the county in which the institutions are located. Board meetings are held on the first Friday of each month. Special meetings are called by the president of the board.

The director has general supervision of the work of the staff, calls staff meetings, administers the general affairs of the station, acts as purchasing agent, and verifies all bills and accounts against the station for the auditing committee. The staff holds regular monthly council meetings. All matters of station policy are referred to the executive board, and all work is subject to its approval. Recommendations of new lines of work are made to the board by the director. Each member of the staff is responsible for the work in his division.

NEBRASKA.

Agricultural Experiment Station of Nebraska, *Lincoln*.

Department of the University of Nebraska.

The governing board of the station is the board of regents of the university, which consists of six members elected by popular vote for terms of six years. By an act of the State legislature of 1899 the funds accruing to the State for the maintenance of the station are paid into the State treasury and must be reapportioned to the station by the legislature biennially. By the same act the State treasurer is made treasurer of the experiment station. The board makes all appropriations of funds to divisions of the station, and the president of the board approves all bills. There are four regular meetings of the board each year. Special meetings are very infrequent, except in the case of certain committees of the board. By resolution of the board of regents at the organization of the experiment station the State Agricultural Society is requested to appoint two of its members and the State Horticultural Society one of its members, the three to constitute a visiting committee to visit the station at least once each year, and to submit its report thereon to the board of regents and the governor.

The director has general supervision of the work of the station, but the policy of the station is determined by a council made up of the president of the board of regents, the chancellor of the university, the director of the station, and the heads of the several departments. The duties of the council are to determine lines of work to be pursued by the station and the general methods under which such work shall be carried on. Meetings are held at stated times or at the call of the director. If the council can not agree as to the work or methods, the final decision lies with the executive committee, but this committee may refer such questions to the governing board, and are required so to refer them if thus requested in writing by a majority of the station council. As yet the regents have not adopted rules governing the station at Lincoln, but the following general rules were adopted September 14, 1903, to apply to the substation which has been located at North Platte and is supported by State funds:

RULES FOR WESTERN SUBSTATION.

The Nebraska experimental substation is in charge of a superintendent under the director of the Nebraska Agricultural Experiment Station and shall be operated as a department of the university.

Expenditures of substation funds when appropriated by the regents are under authority of the director.

Bulletins and reports may be printed from the Hatch printing and stationery fund. The annual report shall be a part of the annual report of the Nebraska Agricultural

Experiment Station. No other expenditure of the Hatch fund at the substation may be made without special authority from the regents.

Official letter heads shall be printed: University of Nebraska, Experimental Substation.

Plans for this station are to be made by the director and superintendent in consultation, and bulletins published jointly.

The departments at the university may be called in consultation upon lines in which they are specialists, and when so called acknowledgment of their services will be made in publishing reports.

NEVADA.

Nevada Agricultural Experiment Station, *Reno.*

Department of Nevada State University.

The board of control of the Nevada Station is the board of regents of the university, which consists of three members elected at a general election, two for a long term of four years and one for a short term of two years. Regular meetings are held four times a year and special meetings as often as desired. No rules for the regulation of station affairs have been adopted. The director is administrative officer of the station.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham.*

Department of New Hampshire College of Agriculture and the Mechanic Arts.

The governing board of the experiment station is a standing committee of five members of the board of trustees of the college, known as the board of control. When once chosen they have always held their positions as long as they remained on the superior board, two of them having thus served since the organization of the station in 1888. Their policy has always been to give the director the widest possible latitude in the management of the station and to allow him to take the initiative in outlining plans of work. Meetings are held quarterly.

The following rules adopted by the board of trustees for the organization and direction of the board of control and the experiment station have been amended once or twice, but only in matters of minor detail:

RULES OF THE NEW HAMPSHIRE COLLEGE AGRICULTURAL EXPERIMENT STATION.

BOARD OF CONTROL.

(1) The experimental work of the station shall be under the immediate control of five trustees, of which number the president of the college shall be one, and known as the board of control.

(2) The board of control may adopt such rules of organization as they deem necessary, which shall not be in conflict with the laws under which the department is organized, or with such regulations as the trustees may from time to time prescribe.

(3) The trustees shall elect a director, whose duties shall be, under the direction of the president of the college, to keep a complete record of the work of the station, to carry on the correspondence, supervise the editing and printing of all bulletins and reports, and shall do all other work necessary to be done about the business of such station which may be required of him by the trustees or president of the college.

(4) This board shall plan and arrange the methods by which investigation shall be pursued and experiments conducted. They shall instruct the director to divide the

work of the station and assign the parts thereof to such persons as may be best fitted by experience and ability to carry forward such work. They shall cause to be kept accurate, detailed accounts of all experimental work and all circumstances surrounding the experiments which can in any way affect them, and such results as the facts show shall be worked out and put in shape for proper reports, to be published from time to time as required by the act of Congress of March 2, 1887.

(5) This board shall require the director to lay before the trustees at each stated meeting of the trustees a plan of such experiments as may seem desirable to undertake, also report the probable expense of the same, and shall designate such instruments, lands, help, and other requirements as they need to successfully carry out the proposed work.

(6) In case any professor of the college shall be employed in the work of the experiment station, this board shall estimate the value of his services while so employed, such estimate to be made upon the basis of his regular salary as such professor, and whatever sum shall be found to be proper compensation for such services, such sum shall be paid from the experiment station fund.

(7) This board shall recommend to the trustees the appointment of all officers and regular assistants employed upon the work of the station or farm. They shall employ all temporary assistants, laborers, janitors, and workmen, who shall be paid from a fund appropriated for that purpose, and report to the trustees at each stated meeting.

(8) They shall regulate the price paid to students for any labor performed on the farm or at the experiment station.

(9) They shall cause to be kept in proper books for the purpose a regular account of all money received and disbursed, the receipts from and expenditures for and on account of the experiment station and farm, or for the construction of buildings or improvement of the premises, and in the farming and gardening operations. These accounts shall be so kept as to show, as near as practicable, the cost of carrying on the farm or garden and the quantity and value of the products of the same.

NAME AND OBJECT OF THE EXPERIMENT STATION.

(1) There shall be, and hereby is, established a department of the college, which shall be known and designated as the New Hampshire College Agricultural Experiment Station, said department having exclusive use of Nesmith Hall.

(2) The object and purpose of such station shall be to fulfill in its scope and work the requirements of section 2 of the act of Congress of March 2, 1887, establishing the same, and to conduct such other researches and experiments bearing directly on the agricultural industry of the State of New Hampshire as may be deemed advisable by the board of trustees.

(3) The board of trustees reserves to itself the power to control all property received and all officers appointed in the experiment station established by the Hatch bill, so called, and the right to remove all such officers when in their judgment the interests of the station require it.

(4) The land belonging to the college and used for agricultural purposes shall be devoted to the uses of the experiment station, placed in the care of the board of control, but subject to the board of trustees the same as the experiment station under the preceding section.

(5) The trustees shall set apart such rooms and buildings as shall be needed from time to time for the purposes of an experiment station on such terms as shall be provided when assigned, subject to the provisions of section 3 of this article.

(6) All records in this department relating to the board of control and director shall be open at any time to the inspection of any member of the board of trustees.

NEW JERSEY.

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

The College Station is under the control of the board of trustees of the agricultural college. The management of the station is delegated to an executive committee of the board consisting of seven members. This committee meets at least twice each year, and members receive their actual expenses. This committee supervises in a general way the work of the station.

The State Station is controlled by a board of managers, consisting of the governor of the State and the board of visitors of the State agricultural college, appointed by him for a term of two years, and composed of two members from each Congressional district, together with the president and professor of agriculture of the college. This board holds a meeting at least once a year to act upon the report of the director and upon such recommendations as he may make. The policy has been to delegate the direction and management of the work of the station to the director. The officers consist of a president, vice-president, secretary, and treasurer.

No rules have been adopted for the government of either station. The director indicates to the heads of divisions the line of work they are expected to carry out.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, *Mesilla Park.*

Department of New Mexico College of Agriculture and Mechanic Arts.

The governing board of the station is the board of regents of the agricultural college, which consists of five active members appointed by the governor for five years each, and confirmed by the legislature. Besides the active members, the governor and superintendent of public instruction of the Territory are also advisory members. The duties of the board, besides the appointment of members of the staff, consist of a general supervision of the affairs of the station, financial and otherwise. The board audits all bills for material ordered by the heads of the different divisions and approved by the director. The general policy of the board is to leave the selection of lines of work entirely to the staff. The regular meetings of the board occur quarterly.

The board has no rules for the regulation of station affairs. The director assumes general supervision of the executive affairs of the station and makes recommendations in regard to expenditures, general policy, etc., to the board of regents for approval. The details of the work of the different divisions are left entirely to their respective heads, but the general plan of work and the policy to be pursued is discussed and passed upon by the station council, which consists of the director and heads of the different divisions.

NEW YORK.

New York Agricultural Experiment Station, *Geneva.*

The experiment station at Geneva is a State institution, nominally a part of the State department of agriculture, but directly under the supervision of a board of control, which consists of the governor of the State, ex officio, and nine other members, whom the governor appoints. The term of office is three years. The duties of the board consist of the appointment of the director and all other persons to carry

on the work of the station and of general oversight of all expenditures. It must make an annual report to the commissioner of agriculture of its proceedings, receipts, and expenditures. The present policy of the board appears to be to leave the determination of the work of the station and of the details of administration fully in the hands of the director and his staff.

Cornell University Agricultural Experiment Station, *Ithaca.*

Department of Cornell University.

The Cornell Station has recently undergone a reorganization and some changes made in the methods of conducting the business. In the past it has been the custom to allow the heads of divisions great freedom in the selection of lines of work, but no expenditures of any kind are made by any department in the university until the executive committee has made appropriations for such expenditures. As the end of the fiscal year approaches, the director is given authority to adjust balances between the divisions or bureaus. Purchases made by heads of divisions must be approved by the purchaser before they are entered in the books and approved by the director before they are paid. A bookkeeper renders a monthly statement for each division of the monthly expenditures of that division. At the close of the year a detailed report of all the expenditures is submitted to the president and acted upon by the board of trustees for approval.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

The North Carolina Station is under the control of the board of agriculture, which has the direction of the State department of agriculture and the agricultural college, the station officers being elected annually and compensation being fixed by the board. The board has adopted the policy of leaving all funds outside of salaries in the hands of the director, to be expended in the way he thinks most desirable in the lines of work submitted to and approved by him.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*

Department of North Dakota Agricultural College.

The North Dakota Station is under the control of the board of trustees of the college, consisting of seven members appointed by the governor and confirmed by the legislature for terms of six years. Board meetings are held monthly. The station council, consisting of the director and heads of divisions, outlines the work in the committee of the whole, and carries it out almost exclusively under verbal agreement. No code of rules has been adopted.

OHIO.

Ohio Agricultural Experiment Station, *Wooster.*

The government of the Ohio Station is vested in a board of control "consisting of five members, not more than three of whom shall belong to the same political party, who shall be appointed by the governor, by and with the advice and consent of the senate, and whose term of office shall be for five years." The board holds an annual meeting in Columbus beginning with the first Monday in March and special meetings at other times and places upon the call of the president and upon the written request of two members of the board. The board appoints the director of the sta-

tion and fixes the salaries and terms of all officers and employees of the station. The director is given control of the affairs of the station in all its departments and is made responsible to the board for the efficient management of station affairs. With the approval of the board, he appoints chiefs of the departments, assistants, and other employees, and assigns them to their respective duties. He has the power to suspend any officer or other employee of the station for cause, but must at once report his action, with reasons for it, to the board of control for final action. The following by-laws have been adopted:

BY-LAWS OF THE OHIO AGRICULTURAL EXPERIMENT STATION.

DEPARTMENTS.

(1) Under the general management and control of the director the station shall be organized in four administrative departments, namely: (1) Executive department; (2) Agricultural department; (3) Horticultural department; and (4) Department of plant physiology and pathology.

The director shall have immediate charge of the executive department, and the other departments shall be respectively under the management of chiefs, to be styled "Agriculturist," "Horticulturist," and "Botanist."

(2) The executive department shall include all lines of work not specifically assigned to other departments. Within this department shall be established sections of chemistry, entomology, and animal pathology, under charge of a chemist, an entomologist, and a veterinarian.

(3) The agricultural department shall be under the supervision of the agriculturist, who shall be superintendent of the farm and of the field, feeding, dairying, and breeding experiments.

(4) The horticultural department shall be under the supervision of the horticulturist, who shall be superintendent of orchards, gardens, and greenhouses, and of experiments with fruit and vegetables, including potatoes.

(5) The department of plant physiology and pathology shall be under the supervision of the botanist, who shall be superintendent of the plant pathological laboratories and of investigations in botany and plant physiology and pathology.

(6) The department chiefs shall have authority to employ such assistants, foremen, and laborers as may be required for the execution of their work, subject to the approval of the director and the board of control.

(7) The department chief longest in service shall be vice-director of the station.

EMPLOYEES.

(1) *Hours of labor.*—Assistants, foremen, teamsters, and laborers employed by the month or year will be required to observe such hours for service or labor as may be designated by the chief of the department in which they may be employed. Ten hours will constitute a day's work in the average for men, and nine hours for women, but this time must be exclusive of time consumed in caring for teams and in going to or from the field or place of work, and in cases of emergency the station may require more than ten hours' work for a few days at a time without extra compensation.

(2) *Sunday labor.*—Every assistant, foreman, or other laborer employed by the month or year will be required to perform, without extra pay, such share of the necessary work of caring for laboratories, teams, live stock, dairy, greenhouses, gardens, orchards, and fruit plantations on Sunday as may be allotted him by the chief of his department, this work to be counted as part of the duties for which his salary or wages is the full compensation.

(3) *Holidays and vacations.*—All employees of the station who are engaged by the year will be permitted to lose two weeks' time each year without reduction of salary or wages, this time to be taken during the following-named holidays or at such

other times as may be mutually agreed upon by the employee and the chief of his department. When more than two weeks' time is lost, inclusive of holidays, a corresponding reduction of pay will be made. Employees engaged by the month for six months or longer will be permitted to lose such of these holidays as may occur during their term of service without reduction of pay.

The holidays referred to are as follows: The first day of January, the twenty-second day of February, the thirtieth day of May, the fourth day of July, the first Monday in September, the day set apart by the governor of the State for thanksgiving, and the twenty-fifth day of December.

(4) *Smoking and the use of intoxicating drinks.*—Smoking when on duty, and the use of intoxicating drinks or visiting of liquor saloons at any time, whether on or off duty, are positively prohibited.

(5) *Protection of records and property.*—It shall be the duty of every employee of the station carefully to guard its work, records, and property; to prevent interference with stakes, labels, or other records; to prevent the taking of fruit or property without the consent of a chief of department, and to report promptly to his chief any accident, mistake, or interference that may affect the results of an experiment.

(6) Any infraction of the provisions of this article, the habitual use of profane or obscene language, or the commission of any other act contrary to the statutes of Ohio by any employee of the station, shall be sufficient cause for the immediate dismissal of such employee from the station's service.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater*.

Department of Oklahoma Agricultural and Mechanical College.

The Oklahoma Station is governed by the board of regents of the college, which consists of the governor of the Territory, ex officio, and five members appointed by him, with the approval of the Territorial council, for a term of two years, or until their successors are appointed. The law requires four regular meetings during the year.

The director of the station is held responsible by the board for the work of the station and the proper management and expenditures of its funds. Each year, at the June meeting of the board of regents, the director presents a statement of the lines of investigation proposed for the next fiscal year. This statement, together with financial estimates, is prepared after consultation with the individual members of the station staff, and on its being approved by the board becomes the basis of next year's work.

All purchases are made on orders issued by the director. No fixed appropriations are made to each of the departments in the station, for the reasons that in many cases two or more departments are concerned in the same investigation, and it is the policy of the station to encourage its officers to regard the work of the station as a unit rather than an aggregation of disconnected parts.

No meetings of the station staff are held, but in all cases the director consults with the members affected by any subject under consideration. The effort is to conduct the station's affairs as nearly as may be in the same manner as a corporation dependent on its success for its existence would be conducted.

OREGON.

Oregon Experiment Station, *Corvallis*.

Department of Oregon State Agricultural College.

The governing board of the Oregon Station is the board of regents of the college, which consists of the governor, secretary of state, superintendent of public instruc-

tion, and the master of the State grange, ex officio, and nine members appointed by the governor for terms of nine years, and confirmed by the senate. This board has general management of all station affairs, and has adopted by-laws as follows:

BY-LAWS OF THE BOARD OF REGENTS, STATE AGRICULTURAL COLLEGE AND EXPERIMENT STATION.

ARTICLE I.

(1) There shall be an annual meeting of this board held at the college building, Corvallis, Oreg., on the third Wednesday in July of each year, at 2 o'clock p. m., which meeting may continue from day to day or adjourn to a day definite as the board may determine.

(2) There shall be a semiannual meeting of this board held at the college building, Corvallis, Oreg., or at such other place as the board may fix, on the first Wednesday after the first Monday in January of each year, at 2 o'clock p. m. Said meeting may continue from day to day upon its own motion.

(3) Special meetings may be called by the president at any time, and shall be called by him upon the written request of three or more members of this board, stating the object or business for which said meeting is called.

(4) At all meetings of this board seven members are necessary to constitute a quorum to do business as a board.

ARTICLE II.

(1) The officers of this board shall consist of a president, secretary, and treasurer, said officers to be elected at the annual meeting in July, 1895, and to hold office for two years, or until their successors are elected.

(2) There shall be elected biennially, at the July meeting of the board, an executive committee of five from its own members, three of whom will constitute a quorum to transact business.

ARTICLE III.

(1) The president shall preside at all meetings of the board, execute and sign all official papers and documents authorized and required by the action of the board. He shall submit at the annual meeting in July of each year, addressed to the governor, a detailed report of the receipts and disbursements, showing the condition, financial and otherwise, of the college and station, with such suggestions and recommendations as may be deemed necessary for the advancement and promotion of the college and station. He may direct the secretary to issue all notices of special meetings, when called by him upon his own motion or upon the written request of members of the board. He shall perform, when required by the action of the board, all duties consistent with the office he holds, and the enforcement and compliance with the orders of the board of regents in the management of said college and station.

(2) The secretary shall keep minutes of the meetings of the board and of the executive committee. He shall countersign and attest all papers, documents, or bonds ordered by the board. He shall have the custody of the corporate seal and affix the same to all such documents requiring his official signature. He shall write all communications, issue all notices when so directed or required for meetings of the board or for any other purpose.

All notices for meetings of the board shall be addressed and mailed to each member thereof at his post-office address at least ten days prior to the day of meeting: *Provided*, that in case of emergency, and under instructions from the president, less time may be given. He shall annually prepare and submit at the meeting in July, a report showing the receipts from all sources on account of the college and station, and also showing the disbursements during the year. He shall perform all other duties consistent with and pertaining to his office, or that may be from time to time required of him by action of this board.

(3) The treasurer shall execute a good and sufficient bond, in such sum as may be required by action of the board, with sureties to be approved as may be directed by the board of regents, said bond to be filed with the secretary after its approval. He shall make written requisitions from time to time on the secretary of state or other parties having the custody of funds applicable by law to the support of the State agricultural college or experiment station. He is authorized to receive, indorse, and receipt for all and any moneys for and on account of the State agricultural college or experiment station. He shall keep a full and accurate account of all funds coming into his hands and the disbursements on account of said college or station, and shall duly account to the board of regents, whenever required by resolution of the board, for all moneys in his hands, custody, or control. He shall prepare and submit at the annual meeting in July of each year a full and complete detailed report for the year then expiring, showing the amounts received from time to time, and the source and upon what account; and also a detailed report as to the disbursements; said report must include and show the financial condition of said college and station. He shall also prepare and submit to the United States authorities, from time to time, such reports of the receipts and disbursements on account of the college and station as may be required by such authorities.

(4) The executive committee provided for in Article II shall execute and enforce the orders and rules of this board, call meetings of said committee, act upon and direct all matters appertaining to the management of said college or station requiring the action of the board of regents during the interval or recess between the meetings of the full board. It shall keep a record of all its proceedings, and the same shall be reported at the first subsequent meeting of the board of regents.

ARTICLE IV.

(1) The board of regents shall select and appoint a president of the college and director of the station, vice-director of the station, and all professors, teachers, and assistant teachers deemed necessary by them, and fix the salary receivable by each. Such appointee shall hold office during the pleasure of the board and shall be removable by the board at any time; the salary of any appointee removed by the board shall cease from the date of such removal.

July 19, 1899, by motion, the clerk and purchasing agent and the printer were placed on the same footing as to term of office as those mentioned in the said by-law.

(2) The board shall at said annual meeting in July, or as soon thereafter as is practicable, prescribe and define the duties of president of the college and station, the professors, teachers, and assistants, for the ensuing year, or until changed by action of the board of regents, and prescribe the studies and pursuits to be taught in the college and station. * * *

ARTICLE V.

These by-laws may be altered, revised, or amended at any regular meeting of the board upon a resolution offered in writing designating the change, alteration, or amendment proposed, upon a vote of two-thirds of the members present. If the amendment is to be acted upon at a special meeting, then the notices to the members calling said meeting shall state the proposed amendment, which must then receive the votes of two-thirds of the members present at such special meeting before it shall be declared adopted.

Adopted June 27, 1895.

The vice-director of the station was made director at the semiannual meeting January, 1902.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station, *State College.*

Department of the Pennsylvania State College.

The governing board of the Pennsylvania Station is the board of trustees of the college, which is represented in the interval between meetings by an executive committee consisting of five members. The governor, secretary of the commonwealth, secretary of internal affairs, adjutant-general, superintendent of public instruction, and the State secretary of agriculture are ex-officio members of the board of trustees. A standing committee of five, known as the advisory committee, consults with the director regarding the work of the station, and makes recommendations to the board, but has no executive powers. This committee meets four times a year. The general policy of the board regarding the station is to give the director large liberty of choice regarding the work and methods, holding him responsible for results. No definite code of rules has been adopted.

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Mayaguez.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

The act of Congress approved March 2, 1901, making appropriations for the Department of Agriculture, provided for the establishment and maintenance of an experiment station in Porto Rico, to be under the control of the Secretary of Agriculture, who manages the station through the Office of Experiment Stations, the Director of which has general supervision of this enterprise. The immediate management of this station is under the special agent in charge.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, *Kingston.*

Department of Rhode Island College of Agriculture and Mechanic Arts.

The governing board of the Rhode Island Station is the board of managers of the college, which consists of five members, appointed by the governor of the State. The term of office is five years, one member retiring annually. Meetings are held regularly once a month, and sometimes more frequently. Two members of the board are appointed a special committee on experiment station, whose duty it is to recommend to the board such changes, additions, etc., as may seem desirable.

The rules adopted by the board of managers are as follows:

RULES OF THE BOARD OF MANAGERS OF THE RHODE ISLAND AGRICULTURAL
EXPERIMENT STATION.

(1) The director of the experiment station, heads of divisions and their first assistants, and the president of the college ex officio, shall constitute the station council. A secretary shall be appointed by the council, whose duty it shall be to keep an accurate record of the meetings.

(2) The station council shall meet monthly, or as often as shall be deemed necessary for the best interests of the work of the station.

(3) The heads of divisions shall report to the council the condition or progress of experiments already begun and suggestions in regard to new experiments. The director shall consider these reports, devise means and methods for continuing the experiments begun, if advisable, and formulate plans for new work, subject to the approval of the board of managers.

(4) All members of the station staff are required to attend to their duties promptly, and a failure to do so without a reasonable excuse, rendered in writing to the director of the station, will subject the delinquent to the deduction of salary to the proportion of time lost, or dismissal, as may be determined by the board.

(5) The director shall present to the board of managers, on or before the regular meeting in March of each year, a list or plan of the experiments proposed for the season following for their approval.

DUTIES OF THE DIRECTOR.

The director of the experiment station is charged with the responsibility and general oversight of all work done in the various divisions of the station, and shall preside at all meetings of the station council. He shall see that the bulletins are issued by the station in accordance with the Hatch Act, so called. He shall annually, in the month of July, make to the board of managers in writing a report of the work of the experiment station for the year ending on the previous June 30, including reports of the heads of divisions. He shall have general oversight and care of all station property.

HEADS OF DIVISIONS.

The head of each division shall conduct with due diligence and care the experimental work properly belonging thereto, and approved by the board, keep all necessary records in permanent form and in such manner that they may be readily understood by anyone, and be responsible for the property of his division.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College*.^a

Department of Clemson Agricultural College.

The government of Clemson College is vested in a board of thirteen trustees, seven of whom are testamentary and six are elected by the State legislature. This board has control also of the experiment station. Immediate supervision of the station is delegated to an experiment station committee of three members of the board. This committee is required to meet at least twice every year, and at any other time the director may request. It inspects the station property and examines into the conduct of station affairs, and reports upon the same to the board of trustees. The following extracts from the rules of the trustees apply to the experiment station:

EXPERIMENT STATION.

The president shall preside at all meetings of the station staff, shall approve or reject requisitions, approve bills authorized by him, and see that no money is expended except as ordered by the board, and with the secretary and treasurer sign all checks in payment of money ordered paid.

The professor of agriculture shall be charged with all work of the station, conforming the same to the law of Congress and the rulings of the Department of Agriculture at Washington and the orders of this board. He shall, at the March meeting, report through the committee on experiment station the experiments

^aTelegraph office, *Clemson College*; express and freight address, *Calhoun*.

conducted during the year, and what experiments he proposes to conduct during the ensuing year, with the amount necessary, and take the order of the board thereon for the same. He shall have general supervision over all the divisions of the station and give general direction to the head of each.

BULLETINS.

The agricultural department shall prepare and issue at least six bulletins annually, covering the experiments in the department, and may send out 30,000 of these publications to farmers in the State, if so many are demanded.

THE EXPERIMENT STATION COMMITTEE.

The experiment station committee shall be composed of five members. This committee shall act as an advisory board to the director of the station, but in no case shall it undertake to control or direct what experiments shall be made or the manner of conducting them. But if the work of the station and the character of the experiments are not planned and conducted in accordance with their conception of the law and rules of the Federal Department of Agriculture, or in what they regard as for the best interests of the people of the State, they shall report the facts to the board, and the board shall take such action thereon as it may see proper. This committee shall meet at least twice a year and as often as it considers necessary for the betterment of the station, or whenever requested by the director of the station. It shall have control and supervision of all property belonging to the station, which they shall inspect at least once a year. It shall closely inspect all the affairs of the station, advise and counsel with the director, and shall report once a year to the board the condition of the station, its property, and also the work being conducted. It shall examine into the conduct and management of the station staff and ascertain and report if the director, vice-director, and all the heads of divisions are performing their duties, and recommend such matters and things as will make the station more progressive and useful. The secretary of the experiment station shall act as secretary to this committee and shall keep accurate minutes of its proceedings, and submit these minutes to the board at least once a year for inspection.

This committee shall particularly examine into the issuing of bulletins, and may report to the board any default, or neglect, or extravagance in the execution of this matter or in any other matter.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, *Brookings*.

Department of South Dakota Agricultural College.

The South Dakota Station is under the management of the State board of regents of education. This body consists of five members appointed by the governor and confirmed by the senate for terms of six years each. It meets two or three times a year. The regulations of the regents regarding the expenditures of funds are embodied in the following:

AMENDED RULES AND REGULATIONS ADOPTED BY THE REGENTS OF EDUCATION OF SOUTH DAKOTA.

Resolved, That the president of each institution under the control of the regents of education of the State of South Dakota be in all respects the head of the institution, subject to such rules and regulations as the regents shall make for his government.

That, in the matter of expenditure, the following rules shall be strictly observed;

the heads of departments in any institution shall have the power of purchasing supplies, but shall observe the following method of procedure:

That whenever it shall be necessary to procure any instruments, supplies, or other material, or hire any labor, he shall submit to the president of the institution, upon a blank form provided for such purchases, statement reciting the necessity for such purchases, upon which requisition the president shall make such indorsement as he deems best, after which said requisition shall be handed to the secretary of the institution and by him recorded in a book kept for such purposes.

The requisition shall then be forwarded to the chairman of the regent's committee of the institution for final action.

If the chairman approves of the expenditure, he shall issue in duplicate to the head of the department an authorization of the same, a detailed list of which authorization said chairman shall furnish quarterly to each regent.

Before the head of the department shall transmit his order for supplies, labor, or material, he shall show his authorization to the secretary of the institution and shall have his order stamped with a suitable rubber stamp, which shall clearly indicate that such expenditure has been properly authorized and that there are funds available for payment of the same. He shall then obtain two blank vouchers to send with the order so that they may be properly receipted.

When the goods are received he shall promptly check up the same and shall certify that the supplies or labor have been actually furnished and shall attach his original and duplicate authorizations to the bills which shall have been made in duplicate and properly receipted and shall present them to the secretary who shall complete and forward the vouchers at the end of month.

In the case of supplies or other materials, the head of department shall take them upon his abstract of property belonging to his department.

In any case where no funds are available for such purchase the secretary shall make such statement upon the original requisition for the information of the chairman of the regent's committee.

Any head of department, instructor, or other employee who shall purchase any supplies, or other material, or who shall hire any labor without first obtaining the proper authority, shall be held personally responsible for such expenditure, and his salary may be held up until satisfactory settlement shall be made with the regents in charge of such institution.

Any rules or parts of rules in conflict with the above regulations are hereby repealed.

Be it understood, however, that all rules relative to the amount of purchases to be paid by the chairman are still in force.

In the case of the experiment station all requisitions shall receive the signature of the director of the station.

Every authority which shall be issued shall be considered to terminate with June 30 of each year, and shall in no case be used in the following year.

A copy of these rules and regulations shall be furnished to each and every person in the employ of the regents of education, and shall be considered in force on and after July 1, 1899.

TENNESSEE.

Tennessee Agricultural Experiment Station, Knoxville.

Department of the University of Tennessee.

The Tennessee Station is governed by the board of trustees of the university, which consists of 30 members, elected by the board for life and approved by the legislature. It meets twice a year and directs the workings of the university and

station. There is a committee in immediate charge of the experiment station. The relations of the station to the president of the university and later to the director are set forth in the following extracts from the minutes of the board of trustees. In the agreement with the president, recorded on the minutes of the board for July 25, 1887, appears the following:

"The said president shall be the financial head of the university and of the experiment station, and all applications for the appropriation of money shall come through him and receive his indorsement; all appropriations shall be for specific purposes, and all bills from the university and the experiment station shall be approved by him before payment, and they shall be paid out of the appropriation made for the particular purpose for which the bills were created.

"That he shall have general charge and oversight of the university, the farm, and the experiment station, shall fix and regulate the courses and means of instruction and experimentation; he shall make all regulations for the government of the university and the experiment station, and shall determine and direct the work of all the officers and agents of the same. * * * Provided that the courses of instruction and the work of the experiment station shall be in conformity with the act of Congress of July 2, 1862, and the act of 1887 establishing experiment stations in connection with the colleges in the several States, and with the several acts of the legislature of Tennessee applicable to the university.

"That all official communications and requests addressed to the board, and all orders for the faculty, shall be made through the president."

At the meeting of July 8, 1890, upon the request of the president, Prof. F. Lamson-Scribner was made director of the experiment station as well as botanist, and it was stipulated at that time that the relations of the president to the board and the station remained unchanged, that the director was to be an executive officer under the board, the farm committee, and the president, in charge of the detail work of the station.

At the meeting of the board of June 5, 1893, a report was adopted setting forth again:

"First, the experiment station is a department of the university, and like the other departments shall be under the general control of the president, aided by a committee of the trustees, to be called the experiment station committee.

"Second, the president shall be the financial head of this department, as of all others, and all the funds of the station shall be appropriated by the board upon his recommendation and for specific purposes, and paid out only on warrants approved by him, which must be fully itemized.

"Third, the officers and assistants of the experiment station work shall be nominated by the president, with the recommendation of such compensation as they should receive," etc.

On May 14, 1901, A. M. Soule was made vice-director, and on February 3, 1903, director. On the latter date his duties were outlined as follows:

"The director of the experiment station shall be in charge of correspondence, publication, bulletin distribution, arrangements for institutes, and the routine work of the station. He shall coordinate the work of the botanist, horticulturist, chemist, librarian, and other officers of the station and direct and assist them when necessary. He shall report to the president and through him to the experiment station committee and the board.

"The duties of the botanist, horticulturist, chemist, librarian, etc., shall be as heretofore, subject to the general supervision of the director, who shall see that they execute the work committed to their care in a proper manner. They will report to the director and through him to the president, the committee, and the board."

TEXAS.

Texas Agricultural Experiment Station, College Station.

Department of the State Agricultural and Mechanical College of Texas.

The Texas Station is governed by the board of directors of the college, consisting of eight members appointed by the governor and holding office for six years. The board distributes the funds of the station among the different divisions at the beginning of each fiscal year. Meetings are held quarterly if necessary, but usually less often. The board has no written by-laws. All new lines of experiment work must be authorized by the director before being carried into execution.

UTAH.

Agricultural Experiment Station, Logan.

Department of the Agricultural College of Utah.

The governing board of the Utah Station is the board of trustees of the agricultural college, which consists of seven members, appointed by the governor and confirmed by the senate for terms of four years each. A State law provides that the trustees shall have charge of the experiment station, purchase land, erect buildings, and appoint necessary officers and assistants to conduct the experiments. Such portions of the by-laws of the board of trustees as relate to the experiment station are given herewith:

EXCERPTS FROM BY-LAWS OF THE BOARD OF TRUSTEES OF THE AGRICULTURAL
COLLEGE OF UTAH.

CHAP. II, SEC. 5—DUTIES OF THE SECRETARY.

The secretary shall attend all meetings of the board, keep a record of its proceedings, and the proceedings of the executive committee, which shall embrace copies of all contracts entered into, and a minute and accurate record of all receipts and expenditures. He shall have charge of all books and accounts of the board, and all records, contracts, bonds, and documents of the college and the experiment station. He shall keep separate accounts of the different funds, and perform all duties that pertain to the office of secretary, or that may be required by the board or the executive committee.

Before entering upon the duties of his office he shall execute to the trustees a bond in the penal sum of five thousand dollars, with two sureties to be approved by the board, conditioned for the faithful performance of his duties, which bond, when approved by the board, or the executive committee, shall be filed with the treasurer. He shall be allowed the necessary expenses incurred by him in the performance of his duties under the direction of the board, or any of its committees, upon vouchers made in the usual manner.

CHAP. II, SEC. 6—DUTIES OF THE TREASURER.

The treasurer shall qualify by taking the constitutional oath of office, and by giving bonds for the faithful performance of his duty, with sufficient sureties, to the State of Utah, in such sum as may be determined by the board of trustees. Said bond must be approved by and delivered to the secretary of state.

The income and revenue of the college shall be paid to the treasurer, and he shall pay out the same on checks, subject to the direction of the board or the executive committee.

CHAP. III, SEC. 6—DUTIES OF COMMITTEE ON AGRICULTURE.

The committee on agriculture shall have charge of the agricultural experiment station in all its departments and of the departments of instruction in agriculture. It shall recommend to the board the purchase of suitable lands, machinery, live stock, etc. It shall, with the advice of the president and faculty of the college, make rules and regulations for organizing and conducting institutes for the instruction of the citizens of the State in the various branches of agriculture, and shall cause to be published and distributed an annual report of such work.

CHAP. IV, SEC. 1—OFFICERS AND EMPLOYEES OF THE COLLEGE.

The board of trustees shall appoint a president of the college, a director of the experiment station, and such professors, instructors, assistants, and other officers and employees as the interests of the institution may require.

CHAP. IV, SEC. 3—DUTIES OF THE DIRECTOR OF THE EXPERIMENT STATION.

The director of the experiment station shall, in accordance with the regulations of the board of trustees and under the general supervision of the president of the college, have general charge of all the work in the several departments of the experiment station.

CHAP. IV, SEC. 6—SALE OF PRODUCTS.

The salable products of the several departments of the college and station shall be sold for cash. The employees who may dispose of such products shall issue receipts in duplicate for all moneys received, giving the original receipt to the purchaser and retaining the duplicate in book form as a record of sales. The persons who make the sales shall report to the secretary and deposit the cash on hand on the first business day of each month.

VERMONT.**Vermont Agricultural Experiment Station, Burlington.**

Department of University of Vermont and State Agricultural College.

The board of control of the Vermont Station consists of four members of the board of trustees of the university, the president of the university, an ex-governor of the State who has served since 1886, and two practical farmers who have served continuously since 1890. One half of the trustees of the university are a self-perpetuating body, while the other half are elected by the State legislature for terms of six years. The duties of the board of control comprise the general oversight of station affairs, the authorization of lines of work, the auditing of bills incurred, and, in general, the shaping of the policy of the station. The general policy of the board as regards work, officers, expenditures, etc., is, while exercising a general supervision, to leave both inception and details of scientific work to the staff and to leave it free to make minor expenditures. Proposed expenditures of medium amounts are usually referred to the director, and of large amounts to the board. The board holds monthly meetings. The board of control has never formulated any rules, regulations, or by-laws.

VIRGINIA.**Virginia Agricultural Experiment Station, Blacksburg.^a**

Department of Virginia Agricultural and Mechanical College and Polytechnic Institute.

The governing board of the Virginia Station is the board of visitors of the college, which consists of nine members, appointed for terms of four years by the governor

^aExpress and freight address, *Christiansburg Depot.*

and confirmed by the State senate. An executive committee of the board of visitors, known as the board of control, has immediate charge of station affairs. This committee meets quarterly. The director is the executive officer of the station, has charge of all correspondence and general direction of work, suggests lines of investigations, edits publications, audits accounts, etc.

It is supposed that the board has never adopted rules and regulations governing the station; at least none have been adopted since the records of the station were burned a few years since.

WASHINGTON.

Washington Agricultural Experiment Station, *Pullman*.

Department of Washington Agricultural College and School of Science.

The board of control of the Washington Station is the board of regents of the college, which consists of five members, appointed by the governor, with the consent of the senate for terms of six years. The board elects a president and a treasurer from its own number, and the president of the college serves as secretary. Meetings are held bimonthly. The policy of the board of regents regarding the organization and government of the station is set forth in the following resolutions, adopted in December, 1901:

"*Resolved*, That the following system of organization of the experiment station be, and hereby is, established. There shall be a director, who shall have the oversight, direction, and management of its work, and who shall determine finally upon all questions of the college and the approval and direction of the board of regents. He shall bear the same relation to the president of the college as other heads of departments of the college.

"There shall be a station staff, consisting of the director and the scientific workers selected by the board of regents. The staff shall hold stated meetings at least monthly, at which it shall discuss and vote upon questions concerning the general policy of the station, methods of experiment station work, the advisability of undertaking or pursuing certain lines of work, the conducting of farmers' institutes, the bulletins and reports to be issued, their contents, and the size of the edition to be issued, and such other matters as may tend to promote the efficiency of the station. The director shall preside at all meetings when present, and shall appoint a presiding officer pro tem who shall preside in the absence of the director. The staff shall keep a record of its proceedings and its recommendations. The final decision and direction of all matters shall rest with the director, subject to the approval and direction hereinafter provided."

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown*.

Department of West Virginia University.

The governing board of the West Virginia Station is the board of regents of the university, which consists of nine members appointed by the governor for terms of six years. Immediate supervision of station affairs is assigned to a committee of three, called the station committee. An auditing committee of the board of regents is annually appointed to audit the expenditures of the station. No system of rules governing the experiment station has ever been formulated. Its relation to the university is the same as that of other departments. The director of the station has, from time to time, been given authority to employ various labor, purchase various supplies, and engage in various experiments, but this has been done by special order of the regents.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison*.

Department of the University of Wisconsin.

The Wisconsin Station is governed by the board of regents of the university, consisting of the State superintendent of public instruction and the president of the university, *ex officio*, and one member from each Congressional district and two members from the State at large, appointed by the governor and holding office for three years.

Immediate oversight of the agricultural college and the experiment station is delegated to a committee of the board of regents, comprising the president of the university, *ex officio*, and five members of the board.

The regents have adopted a code of general by-laws, but no special rules governing the experiment station or the agricultural college have been adopted. All communications regarding the board of regents or agricultural committee are brought to the attention of the president in a communication addressed to him. He either acts upon it or takes it to the board. There is no direct communication between the college professors and the university officials as regents, everything going through the director of the station and president of the university in due form.

WYOMING.

Wyoming Agricultural Experiment Station, *Laramie*.

Department of the University of Wyoming.

The Wyoming Station is under the control of the board of trustees of the university, consisting of nine members appointed by the governor for terms of six years. The rules and regulations adopted by the board are as follows:

RULES AND REGULATIONS OF THE BOARD OF TRUSTEES OF THE UNIVERSITY OF WYOMING
FOR THE GOVERNMENT OF THE WYOMING EXPERIMENT STATION.

Resolved, March 26, 1891, by the board of trustees of the University of Wyoming, That there be, and hereby is, created a department of the university, which shall be known under the name and style of College of Agriculture, which shall include instruction in agriculture, horticulture, and the related sciences; also instruction in the mechanic arts and military science and tactics.

Whereas under an act of Congress approved March 2, 1887, provision is made for the establishment of agricultural experiment stations in connection with the colleges of agriculture in the different States:

Resolved by the board of trustees of the University of Wyoming, That there be, and hereby is, created a department in connection with the college of agriculture, to be known under the name and style of the Wyoming Agricultural Experiment Station. Said station shall be in the immediate charge of an executive committee of three members, selected from the board, subject to such rules and regulations as may be adopted for their government by this board.

Resolved, That the following plan of organization and rules and regulations of the experiment station be, and the same are hereby, adopted:

(1) The executive committee shall have immediate charge of the experiment station and all substations that may from time to time be created by this board. They shall approve and adopt all plans for experimental work upon recommendations of the station council hereinafter provided for, and all matters that may be prepared to be issued in the form of bulletins; audit and approve all bills created in

behalf of the stations, and they shall submit estimates to the board upon which to base appropriations of the station fund; they shall submit an annual report to the board and a report at such other times as the board may order.

(2) The office of director and agriculturist of the experiment station is hereby created, who shall be chosen by the board of trustees, and his compensation shall be fixed by the board.

The office of botanist, horticulturist, and members of the working staff shall be created and filled by the board of trustees.

The offices of assistants in the different sections may be created, filled, and compensations fixed by the executive committee.

The director, secretary of board of trustees, and principal workers on the experiment station, excluding superintendents of substations, shall constitute the station council, which shall hold meetings as may be determined, and keep a record of its proceedings.

The station council shall submit plans for experiments to the executive committee, and propose and submit matter for publication in the form of bulletins.

The printing of bulletins shall be in the charge of the director and secretary, but no publications shall be made unless authorized by the executive committee and the edition prescribed by said committee.

The director shall have charge of the distribution of all bulletins, and shall exercise the franking privilege in connection therewith.

General authority is hereby vested in the executive committee to organize and carry forward the work of experiments for the season of 1891, and until further orders of this board.

The treasurer of the university is hereby authorized to receipt to the State treasurer for all money that may be granted by Congress on account of said stations. He shall keep a separate account of said fund and submit an annual report of the receipts and disbursements on account thereof.

ANNUAL REPORT OF THE ALASKA AGRICULTURAL EXPERIMENT STATIONS FOR 1903.

By C. C. GEORGESON, *Special Agent in Charge.*

Station work has been in progress at Sitka, Kenai, Copper Center, and Rampart. At the three former stations regular forces of station workers have been employed, while at Rampart the cleared land on the reservation has been cultivated for the station by a citizen of the town. We have cooperated with Rev. C. P. Coe in the cultivation of a tract of 20 acres on Wood Island, and to a certain extent we have cooperated with about a thousand citizens of the Territory by supplying them with seeds and aiding their work by correspondence, in return for which they are required to report results.

At the headquarters station we have given our attention mainly to horticulture and particularly to establishing a small nursery with a view to propagating and disseminating hardy varieties of fruit. Some varieties of grain have been tested. The headquarters building has been completed and a frost-proof cellar has been constructed for the winter protection of trees and roots.

We began experiments at Copper Center, where 9 acres were cultivated, resulting in successfully maturing many kinds of barley and oats. Six acres more have been cleared and broken and a log house has been put up for quarters for the superintendent.

At Kenai Station 15 acres have been under culture and 6 acres more have been cleared and broken. The grain did not mature at Kenai this year. It is becoming apparent that grain growing is uncertain near the coast. But forage can be produced in abundance, and it seems wisest to confine our work at that station mainly to animal industry.

The special agent has, as in former years, supervised the weather service in Alaska, consisting entirely of voluntary observers. He has also served as special disbursing agent of the Treasury Department and as quartermaster's agent of the War Department, in so far as these functions might facilitate the investigations in hand.

The special agent visited the stations at Copper Center and at Kenai the past season, and also other points on Cook Inlet.

The correspondence connected with all these matters has been quite large and has required much time and attention.

A BRIEF REVIEW.

Before proceeding to consider in detail the present year's work, it appears desirable to review briefly the work accomplished up to the present time, in order to answer some of the questions which are asked in regard to our work and the outlook for the future.

The Secretary of Agriculture began investigations on the agricultural possibilities of Alaska in 1897. These investigations were limited that year, however, to journeys in the Territory by three gentlemen, namely, Dr. Walter H. Evans, of the Office of Experiment Stations; Mr. Benton Killin, of Portland, Oreg.; and Rev. Dr. Sheldon Jackson, general agent in charge of education in Alaska. The trips of the two first-named gentlemen were confined to the coast region, Doctor Evans going as far west as Unalaska, and also up Cook Inlet. Doctor Jackson made observations along the Yukon while descending this river in the interest of his own special work. Doctor Evans made on his trip a valuable botanical collection confined chiefly to economic plants, with the view of learning what the country afforded in the line of native products. This collection was eventually placed in the National Museum. The report of these three gentlemen is the first authentic information given to the public in regard to the agricultural possibilities in Alaska. It contains statements concerning settlements along the coast, the native flora, and the individual views of the travelers as to the value of the country.

In April, 1898, the writer was sent to Alaska to inaugurate actual experiments in the growing of vegetables and cereals. Hardy vegetables had been grown by settlers in southeastern Alaska and at Kadiak, but so far as can be learned, cereals had never been tried, and few if any settlers in Alaska believed that they could be grown. He was instructed to establish headquarters at Sitka, and to examine the coast region with a view to inaugurate experiments at suitable points, and to aid and cooperate with settlers in their efforts at gardening; to ascertain the value of native grasses and forage plants as feed for live stock, and particularly to experiment with their preservation in silos.

Before the writer became connected with the work a reservation was made by the President of the United States, under date of March 28, 1898, of a tract of land on Kadiak Island, comprising about a quarter section. The writer was instructed to establish the metes and bounds of this, with a view to its use as an experiment station.

At Sitka a reservation was made in the somewhat broken mountain valley back of the town for an experiment station, and by order of the President the lot known as "Castle Hill," which was the only piece of ground the Government had in the town which was not already dedicated to some specific use, was set aside under date of July 18, 1898,

as the site for headquarters building for the Alaska experiment stations. The reasons for locating the headquarters station at Sitka were accessibility and climate. It was deemed necessary to locate this station at a point which could be readily reached by the Department and which could at the same time be in reasonably easy communication with the rest of the Territory. Sitka was deemed to be that point. At that time there was no indication of a speedy opening of the interior. The coast region contained practically the whole population, and it seemed likely to remain the most important region for a long time to come.

The climatic conditions at Sitka were typical of those prevailing over nearly the entire coast region and came nearer to representing an average, both as to rainfall and temperature, in that region than did any other place which could be selected. Sitka was not selected because the conditions were especially favorable to agriculture, either as to soil or climate. On the contrary, it was held that it was unfair to locate experiment stations in the most favored spots, inasmuch as the results would be misleading when compared with results at other places. On the other hand, it was apparent that whatever could be done at Sitka could be done almost anywhere else in the coast region, and in some places much better; and in the light of later experience the choice of location for the headquarters station is in all respects a wise one.

Nothing was done toward improving the land or the erection of buildings this year. The season was spent in examining other portions of the coast region and making surveys of tracts suitable for experimental purposes. One of these was the reservation at Kadiak already mentioned. Another was the selection and survey of a station at Kenai.

The Kenai Peninsula has several thousand square miles of agricultural land on which grass grows abundantly. It can be readily cleared and made into farms, and the soil is suitable for the growth of cultivated crops. A tract of 320 acres, which was deemed a fair average of the land in that peninsula, was selected, and later reserved by Executive order for an agricultural experiment station. It is located back of the village of Kenai, at the mouth of the Kenai River.

By the courtesy of the governor of the Territory, the Hon. John G. Brady, who kindly lent us his garden for the purpose, we were enabled to make the first test of vegetables, grains, and grasses in that year. Many kinds were seeded, and it was found that early varieties of barley and oats matured. So far as known, grain growing had never before been attempted at Sitka or in southeastern Alaska, and the fact that any grain matured seemed so incredible that even old residents of the town did not believe that it could be done again.

At Skagway Mr. George Sexton was employed to grow a number of varieties of vegetables and grains, and here the results were the same as at Sitka. Oats, barley, and flax matured, while all the common hardy vegetables developed normally and proved to be of high quality.

As the net result of the first season's work, it was learned that grain could mature in the coast region, and that settlers could have good gardens, while the reconnaissance of the country resulted in the selection of locations for permanent stations. Observations of soil temperature and weather conditions were begun in the spring and carried on through the season.

The outlook seemed so promising that for the fiscal year ending June 30, 1900, Congress appropriated \$12,000 for the further investigation of the agricultural possibilities of the Territory and for the inauguration of experimental work on the sites selected for stations. The writer was again sent to Alaska, with instructions to begin the erection of a headquarters building at Sitka, for which plans were provided; to begin the clearing and preparation of land both at Sitka and Kenai, and to continue and extend the work of testing vegetables and grains, not only at the chosen stations, but all over the Territory by distribution of seeds to settlers.

Equipments were purchased for the Sitka and Kenai stations, consisting of a yoke of work oxen for each place and the implements required for pioneer work. Two assistants were employed, one to take charge of the work at Kenai and the other to be located at Sitka. The expense of providing equipments and the cost of transportation and freight left comparatively little for the work of clearing and improving land.

The headquarters building was begun—that is, the shell was put up and the lower story so far completed that it could be occupied so as to save rent.

The further testing of cereals, flax, clovers, and vegetables was continued at the Sitka Station, and this year the results were even more favorable than the preceding year. Not only the barley and oats matured, but also spring wheat was now tried for the first time. Red clover seeded in the governor's garden in the spring of 1898 lived through the winter and made a most extraordinary growth, blooming in abundance and many of the earlier blossoms maturing seed.

Some patches of cultivated ground were rented at Kadiak and similar tests inaugurated there. Here the work proved almost a complete failure from several causes, the chief ones being that the soil was poor and gravelly, and that the early part of the growing season proved to be unusually dry.

We made our first test of the preservation of native forage in silo. By arrangements with the governor we filled the silo which he had just completed with a rank grass, locally known as beach grass (*Elymus mollis*), which proved a success. We likewise tested silage at

Juneau by cooperation with Mr. Thomas Knudson, who was induced to build a small silo in his barn the year before. Here the forage likewise kept well, and gave satisfactory results in feeding both horses and cattle.

The clearing of land proved to be a formidable task, especially at Sitka, where the stumps were large and very thick on the ground. We learned that this newly cleared land was practically sterile; that cultivated plants will not grow on it until its acidity has been neutralized and the inert plant food made available by culture and action of the elements.

At Kenai about $5\frac{1}{2}$ acres of land were cleared and fenced. A selection of vegetables and grains were grown, and for new soil the results were good. Early varieties of spring wheat, barley, oats, and part of the flax and buckwheat matured. A log barn 34 by 12 feet was built, as was also a small log silo.

Data as to conditions in other parts of the Territory were collected; seed was distributed; observations of soil temperatures were continued, and the weather observer who was sent to Sitka by the Weather Bureau in 1898 having been withdrawn, the work of supervising the voluntary weather stations in the Territory was also assigned to the Alaska experiment stations.

During the season of 1900, while continuing work along the same lines as heretofore at Sitka and Kenai, our chief energies were centered on learning what the capabilities of the interior were for agriculture, and the special agent spent much of the open season on the Yukon. At Fort Yukon, situated north of the Arctic Circle, a tract of land was selected for possible use as an experiment station and surveyed; and a reservation of 320 acres was also made on the north side of the Yukon, opposite the town of Rampart, in about latitude $65^{\circ} 30'$, and a superintendent was hired to begin work at the latter place. A portion of the lower Tanana was also explored.

We cropped some of the new ground at Sitka. While early varieties of barley, oats, and wheat matured, it was again demonstrated that new land does not produce good crops. The growth was very uneven, and the condition of the soil as yet not suited for experimentation. Vegetables, too, did poorly on the new land. It became evident that it required drainage, culture, and fertilization before good results could be expected. This experience has been repeated every year since.

In 1901 it was demonstrated for the first time that grain would mature on the Yukon, north of latitude 65° N. Winter rye seeded in the fall of 1900 lived through the winter and matured seed by the beginning of August. Barley seeded May 23 was ripe by the middle of August. This was a valuable test. Mr. Isaac Jones, who had been at the Rampart Station since August, 1900, resigned, not wanting to stay there another winter, but in going out he made a reconnaissance

of the region, between Eagle, on the Yukon, and Valdez, on Prince William Sound. He found large bodies of agricultural lands, and there was every indication that farming could be made successful in many places and over large areas in this region.

At the Kenai Station a log house was built for a station building, $1\frac{1}{2}$ acres of land were cleared, making the cleared land at that station about 7 acres, and a number of grains and vegetables were grown successfully, though the grain did not mature as satisfactorily as could be wished.

At the Sitka Station a barn 25 by 50 feet, 2 stories high, was partly completed, and a cottage 30 by 14 feet, $1\frac{1}{2}$ stories high, was built on the farm. It was not completed. Much work was expended on draining and improving the land already cleared. We matured spring wheat, barley, and oats, and winter rye on old ground, and some varieties also on new ground.

Seeds were distributed to about 500 residents of Alaska. The supervision of the weather service was continued, as were the taking of observations on soil temperatures. We began cooperative work with Mr. C. P. Coe, of Wood Island.

Our main efforts during the year 1902 were directed to establishing and equipping a station in the Copper River Valley. To this end Messrs. F. E. Rader and J. W. Neal were sent to Copper Center in July, where a tract was selected for a temporary station and clearing begun. Mr. J. W. Neal was employed as superintendent of the station. He wintered at Valdez, and as soon as the trail was broken in the winter he began hauling in the equipment. It was an onerous task, very hard upon both men and horses.

At the Sitka Station a stone foundation was put under the headquarters building; we never had money to complete it, so a little work was done year by year. A blacksmith shop was built, and the barn and silo were completed.

At Kenai a cow was purchased as a beginning in live stock and 8 acres of new ground cleared, making 15 acres in all cleared at that station.

The season for grain growing was unfavorable all along the coast, and the grain did not mature well either at Sitka or at Kenai. Vegetables on the other hand grew satisfactorily.

The cooperative work at Wood Island was continued. For this the station supplied fertilizers and implements, and Mr. Coe carries on the work and reports the results.

THE OUTLOOK.

These investigations have proved that Alaska has agricultural capabilities beyond the most sanguine expectations entertained five years ago. We are also gradually learning to what lines of work each section is best adapted. In southeastern Alaska and as far west as Prince

William Sound gardening and berry growing are undoubtedly the industries best suited to the conditions. Grain can be matured in all of this section, but there are three drawbacks to its culture: In the first place the amount of land suited to grain growing on a scale commensurable with the ideas of American farmers is too limited. Except in a few places, farms of moderately level land between 50 and 100 acres in extent are hard to find. In the second place much of this land is overgrown with spruce and it would be too expensive to clear it for ordinary farm purposes. In the third place the excessive rainfall in the early autumn renders it difficult to secure grain crops in good condition except now and then when the rains hold off later than usual.

In the coast region west of Prince William Sound there is but little or no timber; instead the country is covered with a wealth of grass, which affords natural pasturage for live stock. The rainfall is rather less than in the wooded districts; hay making is possible, and, of course, winter forage can always be preserved in silos. Grain can be grown successfully there some years, in others not. At Wood Island, for instance, grain was not a success the present year, although it usually matures well and can be saved in good condition; any amount of forage can be produced. In short, the western coast region, including the Kenai Peninsula, is preeminently a stock country.

The vast interior of Alaska will be the farming country in the sense that it is adapted to mixed husbandry. The samples of grain which have been produced at the Rampart Station in about latitude $65^{\circ} 30' N.$, for the past two years, and the samples obtained from this our first year's work in the Copper River Valley, leave little doubt that grain can be grown in these two widely separated regions, and, by inference, elsewhere in the interior. Attention is called to the photographs of grains from these two regions given under their respective headings.

Such being the fact, what is the outlook for farming in Alaska and what are the chances of success for those who come here to take up homesteads? The primary notion of a farm is that it is a factory of food supplies; first, for those engaged in the work, and the surplus for those engaged in other lines of industry. Measured by this standard, the conditions in all sections of Alaska south of the Yukon are such that a good living can be made in one or the other lines of work usually classified as farming. That is, the products of the soil and animal industry will provide an abundant livelihood for all intelligent workers.

The numerous mining camps and the growing cities afford most desirable markets for the surplus above family needs. For confirmation of this I refer to the data published in letters from settlers. Of course markets are not always easily accessible, and a probable market should always be had in mind in selecting a homestead. Beef, mutton, dairy products, chickens, eggs, and garden produce will find a ready market in every settlement and mining camp at prices that leave a large margin of profit under proper management.

Hay and grain are shipped to Alaska in great quantities, and could just as well be produced here, with much profit to the producers. But there are many drawbacks to success that must not be overlooked, the most serious of which is at present the lack of adequate transportation facilities. While this condition makes prices for farm products abnormally high all over the Territory, and particularly at interior points, it also prevents the marketing of any produce at all over extended regions.

The austere nature of the climate is another obstacle. This is so evident as to require no comment. Again, there are the hardships incident to pioneer life everywhere, intensified in a measure by the isolation of the Territory, sparse settlements, and difficult communication. These, however, are yearly diminishing. Many of those who now make their living in whole or in part from the soil are single men, live in cabins, cook their own meals, and in the usual sense of the word have no home life.

The conditions are so diverse in regard to markets, and the crops most profitable to raise, that intending settlers should first come to Alaska and look over the country for themselves before they make a move of so great importance. It is impossible to advise anyone intelligently as to where he had better locate, and what he had better do on arrival, and one shrinks from the responsibility, so much depends on the individual. But with industry and a thorough understanding of conditions farmers can not only make a living in Alaska, but a competence, with greater ease and certainty than in many parts of the States.

PLANS FOR SCIENTIFIC INVESTIGATIONS.

The exigencies of the situation in Alaska have been such that nearly all the time and attention of the employees, both at Sitka and at the substations, have been required for pioneer work. The clearing of land on which to make experiments, the erection of buildings, the purchase of equipments, and the cultivation of experimental crops have absorbed the appropriations made for the Alaska stations.

We have spent much time and energy in collecting information from settlers in the Territory, and in encouraging them to undertake agricultural work. It is now time that work of a more scientific nature should be undertaken, without in any way abating the pioneer work. The high cost of labor, material, and of everything connected with work in Alaska makes it impossible for the station, with the amount of money allowed for its work, to hire specialists. I would therefore respectfully point out that much useful scientific work could be done if specialists now in the employ of the various bureaus and divisions of the Department could be assigned to investigations in

Alaska, in cooperation with the Alaska stations and along the lines of work which the stations should do were the money available.

As a beginning in this work we need a thorough investigation of the native grasses and forage plants, and a study of the way in which the more valuable ones can be rendered of practical utility under culture. Certain species of grasses grow most luxuriantly in particular localities, and native species of Leguminosae, which may be valuable forage plants, grow in certain regions. The study of these plants and the ascertaining of their economic value are of first importance. It is believed that they will do better than introduced species. A specialist from the Division of Agrostology could spend two seasons in Alaska profitably. The Bureau of Chemistry could render aid by analyzing samples, so as to learn what rank native forage plants will take when compared with those under cultivation.

Much work should be done in the near future in plant breeding. Alaska is rich in native berries of many kinds, which are very palatable. The little native cranberry (*Vaccinium vitis-idaea*) is better flavored than the cultivated eastern cranberry. It grows in profusion nearly everywhere in the coast region and in most places in the interior. It could be improved in size and productiveness. Likewise the native salmon berry (*Rubus spectabilis*), which is a large, well-flavored berry. It could probably be improved by crossing with the raspberry. The native strawberry is a vigorous and hardy plant, and could be improved in productiveness and size of berry. So also with the crab apple, the huckleberries, and other native plants. This is proper work for the station, but the Department could aid in it. A general botanical survey of the Territory should be made and specimens for reference should be placed in the herbarium of Alaska plants which has been commenced at the headquarters station.

The soils of Alaska are in some respects peculiar. Much of the vegetable matter is only partly decayed. In places the soil is peaty, in other places sandy, gravelly, or clayey, each differing from the others in fertility and adaptiveness to crop culture. Soil surveys in two or three regions best adapted to agriculture would be of great value to the development of the country.

With the introduction of garden vegetables destructive insects are also appearing. Many complaints have reached the station from southeastern Alaska of insects which destroy root crops particularly, and also kale and similar crops.

The Alaska fund does not admit of the employment of a specialist to study this question, and valuable aid could be rendered to Alaska and doubtless much information collected if an entomologist from the Department could be assigned to duty in the Territory for one or two seasons. The headquarters station could provide laboratory facilities,

and all the stations could serve as centers from which specialists thus assigned could operate. The station could possibly also defray part of the expense while in the field. All this is work that should be done by the station, had it the funds.

An allied interest of scarcely less importance to the Territory is the question of the preservation and proper utilization of the forests. Southeastern Alaska has extensive forests of valuable timber. The best portion of it has already been exempted from use by the creation of a forest reservation. While it is wise to prohibit wanton destruction, it will retard development of the Territory to forbid the conservative use of matured timber. Government supervision is needed in the interior, as settlers come in even more than on the coast, for the reason that the timber there is smaller and that there is none at all over large areas and the merchantable timber is more easily exhausted. The wooded districts must furnish building material and fuel for large areas which have no timber. Timber grows slowly there, and unless the supply is husbanded now future generations are bound to suffer. Steps should be taken to protect the wooded districts from forest fires, which have already caused great destruction in many places, and the cutting of timber should be under the guidance of a forester. The experiment stations in Alaska could assist in this work if given the authority and men and means provided.

INTRODUCTION OF CATTLE.

The cattle which are brought to the settlements in Alaska are of no particular breed or type, and most of them contain some Jersey blood, Jerseys being somewhat numerous on the coast. These cattle are not well suited to the conditions. The cattle best adapted to Alaska should have a heavy coat of hair, like the Galloway or the West Highland cattle, to protect them from the cold rains of the coast region and the severe cold of the interior. The Government would confer a lasting benefit on the Territory by establishing a herd of one or the other of these breeds on Kadiak Island, where a reservation could be made for the purpose. If settlers were permitted to buy the increase at their market value for breeding purposes, the Territory would in a few years be supplied with a type much better adapted to the climate than are the cattle now brought in. I would recommend the Galloway breed.

In this connection it is pertinent to note that a company of beef and pork packers in Seattle has the past summer grazed a herd of about 250 head grade Herefords and about 9,000 sheep on Kadiak Island. It is understood that they have done well. One thousand of the sheep were brought up in the summer of 1902, and wintered in the open as an experiment. Several hundred of them were drowned on one occasion by the rising tide, but many of them wintered in fair shape.

Enterprises of this nature should be encouraged as long as they do not encroach on the rights of settlers. The grass is there going to waste. Turning it into beef and mutton is to transmute it to a useful purpose.

WORK AT SITKA STATION.

The cultural work at the Sitka Station is detailed in the following pages. The weather conditions, which are of such preeminent importance in the latitudes of Alaska, were partly favorable and partly not. The spring was late and cold, delaying planting. August was the most favorable month, having twelve clear days, and the temperature reached a maximum of 79° F., but growth had not been rapid enough up to that time. June had eight clear days, and July only five. The results were that all crops were late in maturing.

VEGETABLES.

The vegetables here noted were all grown on soil which had been cultivated but three years and which is far from being comparable with average good garden soil. It will take several years more to get it in good tilth.

Beans.—Broad Windsor, seeded May 21. June 15, germinated well; strong, healthy plants. July 1, very vigorous grower. July 15, 12 inches high, in bloom. August 1, no pods set yet. August 15, many pods set. September 1, a large number of pods ready for use.

The Windsor bean deserves to be cultivated in every Alaskan garden. The beans should be used when about full grown, but before they begin to ripen. They should be cooked like Lima beans, and compare very favorably with the latter in flavor. It is the one variety of bean which is hardy enough to grow successfully in Alaska.

Improved Golden Wax Bush, seeded May 21. June 15, only a few plants, yellow and sickly looking. July 1, growing slowly, first leaves out. July 15, sickly plants, very poor. August 1, plants small, buds formed, none open. August 15, only a few pods set. September 1, pods large enough to use as snap beans. The few plants which we attempted to raise produced about a quarter of a crop of marketable snap beans; still, on drier soil, they would doubtless have done better. Occasionally one hears of bush beans doing well, but ordinarily they are not a sure crop.

Thorburn Dwarf Lima, seeded June 8. July 1, germinated poorly, plants yellow and sickly looking; many plants pulled up or broken off by ravens. July 15, not doing well. August 1, failure.

Beets.—Extra Early Egyptian, seeded May 21. June 15, up and doing very well. July 1, growing slowly. The same condition July 15. August 15, doing well in last ten days. September 1, growing fast. October 3, not large, but of good quality.

Golden Tankard, seeded May 21. June 15, up and doing very well. July 1, growing slowly. July 15, making slow growth. August 15, doing better in last ten days. September 1, growing fast.

Mammoth Food, seeded May 21. June 15, up and growing some. Grew slowly during July. August 15, began to grow more rapidly. September 1, growing fast.

Eckendorfer, seeded May 21. June 15, up and growing some. Grew slowly during July. August 15, growing more rapidly than heretofore. September 1, growing rapidly.

All of these beets were small. The soil was too wet. Beets can be grown successfully in Alaska. The writer has seen them 4 inches in diameter on warm, well-drained soil.

Brussels sprouts.—Improved Half Dwarf, seeded in hotbed April 20. Plants set out June 6 and 9. July 1, growing rapidly. September 1, plants very thrifty, sprouts slow in developing, much variation between individuals. September 15, some plants slow in developing sprouts, others have fine auxiliary heads and are all that could be desired.

Cabbage.—Early Winningstadt, seeded in hotbed April 20. Plants set out May 27 and June 20. July 1, all doing well. July 15, all doing well, but the early-set plants are no better than those planted out four weeks later. August 15, thrifty, not heading. September 1, heads forming, none solid yet. September 15, fine solid heads.

Early Jersey Wakefield, seeded in hotbed April 20. Plants set out June 6. July 1, slow growth. July 15, growing quite well. August 1, growing nicely. August 15, thrifty, beginning to head. September 1, some heads bursting, excellent quality. October 1, very fine cabbage.

Early Summer, seeded in hotbed April 20. Plants set out June 6, 9, 12, and 20. July 1, growing rapidly. July 15, ahead of any other variety at this time. August 1, growing nicely. August 15, thrifty, but not heading yet. September 15, heading well. October 3, headed nicely.

Extra Early Express, seeded in hotbed April 20. Plants set out June 6 and 13. July 1, vigorous, making rapid growth. July 15, doing well. August 1, growing nicely. August 15, thrifty, not heading. September 15, heading well. October 3, headed nicely. A desirable early variety.

Late Drumhead, seeded in hotbed April 20. Plants set out June 6 and 13. July 1, making very slow growth. July 15, doing well. August 1, growing rapidly. September 1, no heads formed; plants thrifty. September 15, beginning to head. October 3, headed nicely. October 26, large solid heads still growing.

Danish Ball Head, seeded in hotbed April 20. Plants set out June 6, 9, and 13. July 1, slow growth; not fully established. July 15,

doing quite well. August 1, growing rapidly. September 1, large and thrifty, but no heads at this date. October 15, large, solid heads of fine quality.

Moscow, seeded in hotbed April 20. Plants set out June 20. October 15, small round heads on tall stalks. This variety has nothing to commend it. For a long time it gave little hope of producing more than small bunches of leaves, and several plants failed to head. The stalk is abnormally tall. Seed from Moscow, Russia.

Cauliflower.—Extra Early Snowball, seeded in hotbed April 20. Plants set out June 6 and 9. July 1, rather backward; slow in becoming established. September 1, very fine heads; quality excellent. Several heads 9 inches in diameter.

Carrot.—Chantenay Half Long, seeded May 20. June 6, coming up. June 15, making good growth. July 15, doing well. August 1, doing very well. August 15, making better growth than earlier in the season. September 1, very fine, of marketable size at this date and still growing.

Other varieties seeded were Long White, Half Long Danvers, Champion, and Half Long Scarlet Horn, but the ground proved to be too wet for normal development.

Celery.—Giant Pascal, seeded in hotbed April 20. Set out plants June 24. July 1, growing well. July 15, very yellow, poor prospects; that reset in spent hotbed doing well. August 1, that in spent hotbed doing well, ready to blanch.

Improved White Plume, seeded in hotbed April 20. June 24 set plants in spent hotbed. July 1, growing well. August 1, doing well. August 15, ready to blanch.

Golden Self Blanching, seeded in hotbed April 20. June 24 set plants in spent hotbed. July 1, growing well. July 15, doing well. August 15, ready to blanch; that which was transplanted to open ground was a failure. September 1, excellent; that which was left standing on spent hotbed is better than that which was reset. September 15, very fine, from 2 to 3 feet high.

The garden soil is still too raw and in too poor tilth to produce good celery, hence the plants set there did not do well. The rich soil in the old spent hotbed suited it and it grew to compare with celery found anywhere.

Kale.—Dwarf Green Curled Scotch, seeded in open ground May 21. June 6, up, very good stand. July 1, growing well. July 15, growing very fast. September 1, equals that reset from hotbed. September 15, very good. October 3, exceedingly fine.

Dwarf Green Curled Scotch, seeded in hotbed April 20. Plants set out June 9. July 1, very slow. August 1, growing slowly. August 15, growing better than earlier in the season. September 1, growing very well. September 15, very good. October 3, exceedingly fine.

Scotch Kale is one of the vegetables which should be found in every Alaskan garden. It never fails. It is raised almost as easily as turnips. It is hardy and can be left out under the snow all winter. In fact it improves in flavor by being frozen. It should not be eaten raw, however. It is not a salad plant, but boiled with meat and served in the various ways known to good cooks it is one of the most delicious greens grown.

Kohl-rabi.—Trondhjensk, seeded June 9. The few plants raised grew into tender bulbs. It also is a vegetable specially adapted to northern climate. Can be sown in the open ground and thinned or in a hotbed and transplanted like cabbage. The stem forms a bulb at the surface of the ground of the size of a large turnip. It is also good cattle food.

Lettuce.—Big Boston, seeded in the open ground May 21. June 6, up, fair stand. July 1, doing splendidly. August 1, ahead of transplanted lettuce of same variety.

The same variety was transplanted from the hotbed May 27. It grew slowly, and August 1 was just beginning to head.

All varieties of lettuce do well in Alaska. No one kind can be recommended as suited to the whole Territory. The vigorous, large-growing sorts are as a whole to be preferred to the smaller and more delicate sorts. The variety known on the Pacific coast as the San Francisco Market (not grown at this station this year) is on the whole, perhaps, the best so far tested.

Parsley.—Extra Curled, seeded in the open ground May 21. A single short row grown at the station can not be surpassed. The leaves are fully a foot tall and form a thick mass of crisp green. It is one of the vegetables suited to Alaska and should be found in every garden, and it should be used much more freely than is generally the case.

Peas.—Hosford Market Garden, seeded May 21. June 6, up, good stand. June 15, growing well. July 1, 5 inches high, growing slowly, yellowish. July 15, 16 inches high, look well. August 1, in bloom. August 15, have formed some pods. September 1, most prolific variety, excellent flavor.

McLean Little Gem, seeded May 21. June 6, up and good stand. June 15, growing well. July 1, 6 inches high, good color. July 15, 18 inches high, a few blossoms. August 1, in bloom. August 15, has formed some pods. September 1, excellent quality.

Earliest of All, or Alaska, seeded May 21. June 6, up and good stand. June 15, growing rapidly, ahead of other varieties. July 1, 12 inches high, growing well, yellowish. July 15, 2 feet high, in full bloom. August 1, set pods. August 15, 4 feet high, pods large enough for use. September 1, very fine, quite prolific.

Dwarf Telephone, seeded May 21. June 6, up and good stand. June 15, growing rapidly. July 1, 8 inches high; doing well, but rather yellow. July 15, a few blossoms. August 1, set pods. August

15, 6 feet high, no pods mature enough for use. September 1, very vigorous grower, but not a prolific bearer, peas of good quality.

Swedish No. 6428, seeded June 8. June 15, just peeping through the ground. July 1, doing very well. July 15, not doing so well, leaves dropping off, 12 inches high. August 1, plants vary much in growth, not vigorous. August 15, in bloom. September 1, some pods.

Of the foregoing and, indeed, of all the varieties tested at this station, the sort known as Earliest of All, or Alaska, has done the best. It reaches a height of 3 to 4 feet, is an early bearer, and the peas are of excellent quality. This is one of the sorts we can recommend for general planting.

Potatoes.—Planted May 6, 7, and 8. August 1, growing well, in bloom, no apparent difference between the rows treated with sodium nitrate and those not treated. September 1 vines cover the ground, no effect of nitrate noticeable. October 1, tops frozen down. The potatoes were dug October 9, 10, 12, and 13; yield, 112 two-bushel sacks.

The lot on which these potatoes were grown is old ground and belongs to the Russian Church, but kindly loaned to the station. It is three-fourths of an acre in extent, and was manured with seaweed at the rate of 20 tons to the acre. The potato used is known as the Yakima, a rather long, white potato extensively grown about Yakima, Wash. It is probably the Burbank somewhat modified by long culture in that locality. This lot was planted to potatoes for two reasons: First, because the ground was so weedy as to be good for nothing else; and secondly, because there are very frequent demands on the station to furnish seed potatoes to the natives in various parts of the Territory, which demands we have heretofore been unable to comply with.

Half the plat was fertilized with nitrate of soda at the rate of 150 pounds to the acre, it being applied to six rows alternately—six rows being fertilized and the following six not. But as stated in the notes above, there was absolutely no effect from this application. The yield of potatoes was at the rate of nearly 300 bushels to the acre.

Rhubarb.—Seeded in the open ground May 20. June 15, a few seeds germinated, good plants. July 15, doing well, also that which was reset. August 15, growing well. The plants have made a satisfactory growth for the season.

Ruta-baga.—Large White. Seeded a short row May 20. July 15, rank growth of top, but root development slow. September 15, very good, getting large. October 3, roots are of normal size.

Sage. Sown May 21. July 1, growing nicely. July 15, growing exceedingly well. August 15, very thrifty growth. September 1, very good. September 15, good plants, fine growth.

Tomato.—J. J. Bogardus' Monster, seeded in hotbed April 20. Set out June 12. June 15, disturbed by ravens. June 30, set more plants. July 1, plants set out mostly dead. July 15, plants left in hotbed doing well. August 1, plants in hotbed doing well, some buds formed, those transplanted making very little growth.

A few plants were set on the south side of the house in the warmest place that could be found. While the plants lived, grew, and blossomed, they produced no fruit.

Turnips.—The following varieties were seeded May 20: Purple Top Strap Leaf, two Swedish varieties (not named), No. 6178, yellow, and No. 6177, white, both from Mustiala, Finland. All made a normal growth and all suffered from the attacks of root maggot.

NURSERY WORK.

We have started a nursery on a small scale with a view of propagating fruit trees and fruit bushes for the purpose of distributing them over the Territory to be tested. Only hardy, early maturing varieties were selected.

The trees were planted 3 by 6 feet apart in a scion orchard for the purpose simply of propagation.

We also procured 500 seedling apple trees to use as stocks. Only a few were grafted, however, for the reason that the trees did not have wood for scions, having been pruned to a whip before shipment.

The new ground in which these trees have been planted is not in satisfactory condition for fruit trees. Nevertheless, nearly all of the varieties named have made a fairly good growth, as noted below. The fall rains have a tendency to induce a too late growth, and the wood has therefore not matured as it should have done before winter. This condition will probably be a serious drawback to the successful growing of fruit trees in the coast region of Alaska.

APPLES.

Duchess of Oldenburg, 19 trees, all alive and doing well. This variety seems to be the most vigorous of any in the list. Average growth for the season, 18 inches.

Red Astrachan, 19 trees, all lived and appear healthy. The growth was only moderate. The average length of the new wood was 16 inches.

Red June, 20 trees, healthy, but only moderately vigorous. Average growth was 16 inches.

Raspberry, 19 trees, made a vigorous growth; one of the strongest growers in the lot. Average length of the new shoots, 2 feet.

Yellow Transparent, 20 trees, thrifty, but only moderately vigorous. The new growth was not up to the average of the others. The average length of the new branches was 14 inches.

Maiden Blush, 20 trees, made a fairly good growth, and the trees are healthy. Average length of the new shoots, 15 inches.

Early Harvest, 19 trees, were backward at first, but later in the summer they took on new vigor. Average growth, 18 inches.

Sylvan Sweet, 20 trees, one of the most vigorous varieties in the lot. It has been thrifty from the start. New growth average, 22 inches.

Eureka, 20 trees, a few of the trees of this variety were backward, but the majority did well. The new growth in the latter averaged 24 inches.

Tetofsky, 20 trees, healthy, but slow growers. The average length of the new growth was 12 inches.

Bryer Sweet, 21 trees, started out well, but did not keep up a vigorous growth. Average height of the new shoots, 15 inches.

Lowell, 20 trees, moderately thrifty. Average growth, 18 inches.

Standard Hibernial, 3 trees, moderately thrifty. Average of new growth, 15 inches.

Hyslop, 1 tree, only moderately vigorous. Average of new growth, 9 inches.

Whitney Crab, 20 trees, strong growers and healthy trees. Average growth, 18 inches.

Martha Crab, 20 trees, like the foregoing the trees of this variety made a good growth. Average length of shoots, 18 inches.

Transcendent Crab, 3 trees, rather stunted and scrawny. Average of new growth, 10 inches.

CHERRIES.

English Morello, 11 trees, a few individuals rather backward, but the majority have made a rather satisfactory growth. Average length of new shoots, 18 inches.

Ostheimer, 18 trees, not so vigorous a grower as the English Morello. Average length of new shoots, 10 inches.

Early Richmond, 20 trees, this variety has exceeded all the rest in vigor. Average length of new growth, 25 inches.

Dyehouse, 19 trees, seem inclined to make a close, bushy top, but it made fine growth. Average length of new shoots, 20 inches.

PLUMS.

Forest Garden, 10 trees, leaves affected by a fungus toward the end of the season. Average growth, 18 inches.

Hawkeye, 10 trees, very thrifty, making a good showing for the season. Average growth, 22 inches.

Red June, 9 trees, much less vigorous. Average growth, 18 inches.

De Soto, 10 trees, very vigorous. Average length of new shoots, 2 feet.

These varieties will be propagated and distributed to various places in the Territory for trial.

We have a few blackberry bushes of the following varieties: Snyder, Turner, Taylor, and Fuller's Colorado. They are alive, but that about all that can be said of them at present. The blackberry is not likely to do well in Alaska.

RASPBERRIES.

The raspberry is indigenous to Alaska. It is found all through the central part of the Territory, and even north of the Arctic Circle.

We have 600 bushes of a variety common in the gardens about town; it is probably the Cuthbert. They do exceedingly well here. In addition we have a half-dozen bushes each of Miller and Loudon, both of which have made vigorous growth.

CURRENTS.

Current bushes also do well in Alaska. We have some 200 bushes about evenly divided between the red and the white currants, which have been propagated from bushes found here in town. In addition we have a few plants each of Fay Prolific, White Grape, Victoria, Ruby Castle, and Manitoba Amber. We also have a few black currant bushes. These will be propagated to the extent of the wood they can furnish.

Of gooseberries we have a few of which the names are uncertain and more will be procured.

Of ornamentals we have a few bushes each of the Siberian Honey-suckle, the Siberian Wild Olive, Sand Cherry, *Rosa rugosa*, *Pyrus baccata*, the lilac, and the June Berry. It is hoped that we can add considerable to this list next spring.

STRAWBERRIES.

Of strawberries we have a start of the following varieties: Excelsior, Lady Thompson, Saunders, Haverland, Enhance, Bismarck, New York, Brandywine, and Bubach.

We have also in addition a start in the native wild berries with a view to see if they can be improved. They are prolific growers, but very poor bearers.

CRANBERRIES.

We obtained a few dozen cranberry plants from Wisconsin last spring, and most of these are alive, but it is a question if they will survive the winter. The native Alaskan cranberries, *Vaccinium vitis-idaea* and *Oxycoccus oxycoccus* are abundant in this neighborhood and yield berries of most excellent quality. We have set out patches of both species with a view to bring them under culture and see if they

are susceptible of improvement. The *Oryzococcus* is a very shy bearer, and in the wild state is not of much value on that account.

FIELD CROPS AND FORAGE PLANTS.

The season on the coast was not favorable to the growth of grain. The spring was cold and late and the fall began early. Nowhere on the coast have grains been a success this year. Nevertheless, a few varieties matured here at the Sitka Station.

It is becoming more and more apparent that the coast region is not well adapted to grain growing. Forage can be grown in abundance, but the difficulty of saving the grain, even when it matures, on account of the excessive fall rain, will render grain growing impracticable except on a very small scale. Hereafter grain growing at the Sitka Station will be limited to the testing of varieties which appear to have special merit.

The following notes were taken on the varieties tested this year. The patchy nature of the growth of all these grains was due to the soil:

BARLEY.

Lapland, seeded May 29. Coming up June 8. June 15, 3 inches high, fair stand, yellow in spots, but on the whole looks well. July 1, patchy; best 15 inches high; good color. July 15, 30 inches high; mostly very good; heading. August 1, 3 feet high; heads well filled; many small ones; a few smutty heads. August 15, heavy heads; stands up well; beginning to ripen. September 1, fine; ready to harvest. September 5, cut.

Success, sown May 29. Coming up June 8. June 15, 2½ inches high; thin, poor stand. July 15, not a success; very thin; a few spots growing well; probably old seed accounts for poor stand. August 1, 2 feet high, in full bloom. August 15, heads mostly well filled. August 29, well-filled heads, beginning to ripen. September 15, nearly ready to harvest. Cut September 21.

Sisolsk, seeded May 23. Coming up June 6, germinated slowly. June 15, 4 inches high, half stand. July 1, average 9 inches high, very thrifty. July 15, 2 feet high; has good color. August 1, 3½ feet high, good heavy stem, in full head, beginning to bloom. August 15, grain in dough, straw soft, somewhat lodged. August 29, beginning to ripen. September 15, ready to cut. Harvested September 19.

Manshury, seeded May 8. Germinated slowly on account of cool weather. Was up by May 25. July 1, 12 inches high, spotted, has good color. July 15, 2 feet high, looks well. August 1, 3½ feet high, generally good, in full head. August 15, badly lodged, short heads, well filled. September 10, ripe.

Finnish barley and Black Hulless barley were also seeded, but were failures, because the soil was not sufficiently subdued to grow grain successfully.

OATS.

Sixty Day, seeded May 23. Came up June 6. June 15, 3 inches high, good stand, looks well. July 1, 8 inches high, very thrifty growth. July 15, averages 20 inches high, looks very thrifty. August 1, 3 feet high, very fine, in full head. August 15, very fine, somewhat lodged, large heads well filled. August 29, nearly ripe, lodged badly. September 11, harvested. This is one of the earliest oats we have tested. It can be depended on to mature, but it has a weak straw and lodges badly. The grain is also small and light.

Burt Extra Early, seeded May 29. Came up June 8. June 15, 2½ inches high, fine even stand. July 1, 8 inches high, fine even stand and growth. July 15, 18 inches high, good color in best places. August 1, 2½ feet high, even stand, fully headed. August 15, medium heads well filled, standing well. August 29, well-filled heads, beginning to ripen. September 15, somewhat lodged, ripening. September 19, harvested.

This follows Sixty Day in earliness and it has a better straw and somewhat heavier grain. It, too, can be depended on to ripen.

Swedish Select, seeded May 7, germinated slowly. June 15, 4 inches high, good stand, looked well. July 1, best 15 inches high, growth spotted. July 15, just heading, poor spots treated with sodium nitrate show no more growth but better color than similar spots untreated. August 1, 3½ feet high, general average good, in full head. August 15, fine, stands well, large, well-filled heads. September 1, very fine, nearly ready to cut. September 15, ready to cut and harvested two days later. While not an early variety it has nevertheless done well at this station for two seasons. It stands up well under the strain of severe storms, and it has an unusually large, plump grain.

Improved Ligowa, seeded May 29. Coming up June 8. June 15, 2½ inches high, excellent stand. July 1, 8 inches high, good, thrifty, even growth. July 15, best 18 inches high, good color. August 1, partly headed. August 15, medium heads lodged in places. September 1, very good, shows but very little signs of ripening. September 15, lodged badly, nearly ripe. This well-known variety requires too long time to mature to make it a sure crop every year. It has a fairly good straw and large, plump grain. It is a good variety for hay or silage.

Nameless Beauty, seeded May 29, came up June 8. June 15, 2½ inches high, looks well but thin stand. July 1, 6 inches high, very good, even growth. July 15, 18 inches high, generally very good. August 1, poorest in head, ranker growth just beginning. August 15, very even, medium heads, standing up well. September 1, very fine, lodged badly, little signs of ripening. September 15, ripening. September 21, harvested. One of the rankest growers we have tested

and excellent for hay and silage, but too late to mature on the coast before the fall storms set in.

WHEAT.

Romanow Spring, seeded May 7 came up May 23. June 15, very uneven stand; on high ground, 6 inches high; on poorer ground, 4 inches high. July 1, best 15 inches high. July 15, 2 feet high, good color, heading. August 1, 4 feet high, in bloom, heads good size, some smut. August 15, badly lodged, on which account development is retarded. September 1, fairly good, grain just in dough. September 15, heads small but well filled, grain plump, ripening. Cut September 19. Seed imported from Russia by the U. S. Department of Agriculture. It does not do as well here as did the seed of an earlier importation by the same name. This variety is the best spring wheat we have tested.

RYE.

Giant French Winter, seeded September 10, 1902. June 10, heading. June 15, 3½ feet high, heads 1½ to 3 inches long. July 1, 5 feet high, many short stalks, in full bloom. July 15, grain in soft dough. August 1, beginning to ripen, well filled, many small heads. August 15, nearly ripe. August 25, harvested. Of several varieties seeded this was the only one that did not winterkill. They were killed by too much water rather than severe cold. The heads are small but the grain is of fair quality.

FLAX.

Riga (for fiber), seeded June 4. Coming up June 15. July 15, 3 inches high, growing slowly, good color, badly mixed with mustard. August 1, 20 inches high, bloom buds formed. August 15, 2 feet high, in bloom. August 29, nearly through blooming. September 15, 3 feet high, badly lodged in places, seed fully formed, but not ripe. October 3, ready to pull. The ground was too wet for the best results, and not sufficiently subdued. The quality was injured by lodging of the straw. Good fiber flax can be grown on the coast wherever suitable soil can be found.

BUCKWHEAT.

Russian variety, seeded May 23. Came up June 6. June 15, has two leaves, fine stand, looks well. July 1, 4 inches high, growing well. July 15, 18 inches high, in full bloom. August 1, exceedingly fine, bees working on it vigorously. August 15, bloom nearly all dead, seed well formed, will yield well. August 29, nearly ripe. Cut September 12. Early maturing varieties of buckwheat may be depended on to mature in the coast region.

FORAGE PLANTS.

Flat pea (*Lathyrus sylvestris*), seeded June 8. July 1, no sign of germination. August 1, very good stand, plants small. September 1, making slow growth. This is the second attempt we have made to grow this forage plant. It was first seeded in 1898 and survived for three years, but at no time did it grow vigorously enough to make a promising forage crop when compared with clover and vetches. The present patch is located where it is hoped it may do better.

Red clover, seeded in the spring of 1902. July 1, just coming into bloom, very good, 20 inches high. July 15, 2 feet high, fine, full bloom. August 1, heads well filled with seed. August 15, seed yet soft. September 1, early heads have ripe seed.

White clover, seeded in the spring of 1902. July 1, 6 inches high, fine, in bloom. July 15, in full bloom, growing rapidly. August 1, heads well filled with seed. August 15, seed yet soft. September 1, early heads have ripe seed. Both red and white clover have done well at this station. The small patches on which they have been tested would indicate that they may be counted on to yield a large amount of pasture on old ground. On new ground the growth is spotted as in the case of grains. The summers are too wet, however, to cure clover hay except now and then, when the season is dryer than usual.

GRASSES.

The following species were seeded in trial plats in the spring of 1902. The ground was new and the growth uneven, particularly last year. This year the difference in growth in the same patch was less noticeable. None of them suffered in the least from winterkilling, and all matured seed. Tall meadow-oat grass (*Avena elatior*) is so far the most promising grass of the species here tested. In places it grew to a height of 6 feet and covered the ground densely with leafy forage. None of the grasses were cut until fall in order to watch the development of seed.

Perennial rye grass (*Lolium perenne*), June 15, 16 to 18 inches high, fair stand, headed. July 1, 20 inches high, fully headed, too stemy for hay. July 15, 2 feet high, in bloom. August 1, in bloom. August 15, seed matured. A lawn grass. The yield is too light for hay, but it will furnish early and late pasture.

Orchard grass (*Dactylis glomerata*), June 15, 2½ feet high, partly headed out. July 1, in full head, well leafed, make good hay. July 15, 4 feet high, in full bloom. August 1, heads well developed, seed in dough. August 15, seed in hard dough. September 1, seed ripe. A leafy pasture grass and one which will also yield considerable hay.

Timothy (*Phleum pratense*), June 15, 18 to 24 inches high, fair stand. July 1, just in head, average 2 inches in length, well leafed, make good

hay. July 15, in head, 3 feet high. August 15, seed in dough. September 1, seed ripe. While it has done well, this popular grass does not promise to be as valuable for this region as tall meadow-oat grass or orchard grass.

Red top (*Agrostis vulgaris*), June 15, 12 to 15 inches high, fair stand. July 1, 18 inches high, just coming into bloom, good stand and color. July 15, in head. August 1, no bloom yet. August 15, in bloom. September 15, ripe seed. Only the earlier promises to mature seed.

Tall meadow fescue (*Festuca elatior*), June 15, very thin stand. July 1, 2 feet high, in head, poor stand. July 15, in head. August 1, in bloom. August 15, seed in dough. September 1, seed ripe. A fairly promising grass.

Kentucky blue grass (*Poa pratensis*), June 15, 12 inches high, very poor, heading out. July 1, headed, fairly good. July 15, just past blooming. August 1, seed getting hard, good heads. August 15, seed mature. This plat happened to be seeded on a spot of poor soil. The chief merit of blue grass is that it is ready to cut for hay early in the season before the unsettled weather begins.

Tall meadow-oat grass (*Avena elatior*), June 15, heading out, excellent. July 1, 3 feet high, in full head, heads 4 inches long. July 15, 6 feet high, in bloom. August 1, heads and seed well developed. August 15, seed in dough. September 1, seed ripe. In point of yield ahead of any here tested. This moist climate stimulates it to very luxuriant growth.

Meadow foxtail (*Alopecurus pratensis*), June 15, 2 feet high, in bloom. July 1, 2½ feet high, in bloom very good, heads 2½ inches long. July 15, 3½ feet high, in full bloom. August 1, heads well filled, beginning to ripen. August 15, seed mature. Will have value as an early hay grass.

COPPER CENTER STATION.

Last year a few acres of ground were cleared near Copper Center and some winter grain seeded preparatory to opening an experiment station in the Copper River Valley, and Mr. J. W. Neal, formerly connected with the California Agricultural Experiment Station, was placed in charge. This year more ground was cleared in the spring, so that an area of about nine acres was seeded to spring grain.

The result this season has been quite encouraging, although as the weather reports from the station indicate, there has been frost in every month of the year, nevertheless Manshury, Lapland, Sisolsk, Royal, Trooper, No. 6175, Black Hullless, and No. 9133, barley, and Nameless Beauty, Burt Extra Early, Sixty Day, Finnish Black, No. 2800, and Swedish Select oats matured. Hardy garden vegetables grew well, as did also grasses and clover seeded this spring. Spring wheat did not mature. A frost on August 27 killed it before it was fully ripened. Plate V shows samples of the varieties of grain which ripened there.

While an experiment station must be maintained in the Copper River Valley, the present location of the station may not be found to be the most desirable. When railroads are built through this country the station should be moved to the railroad so as to be accessible. Two companies have filed plans with the land office showing the lines they have projected through this part of the interior, but it will be wisest not to select a permanent site for a station until one or the other of these railroads is actually built.

EQUIPMENT OF THE STATION.

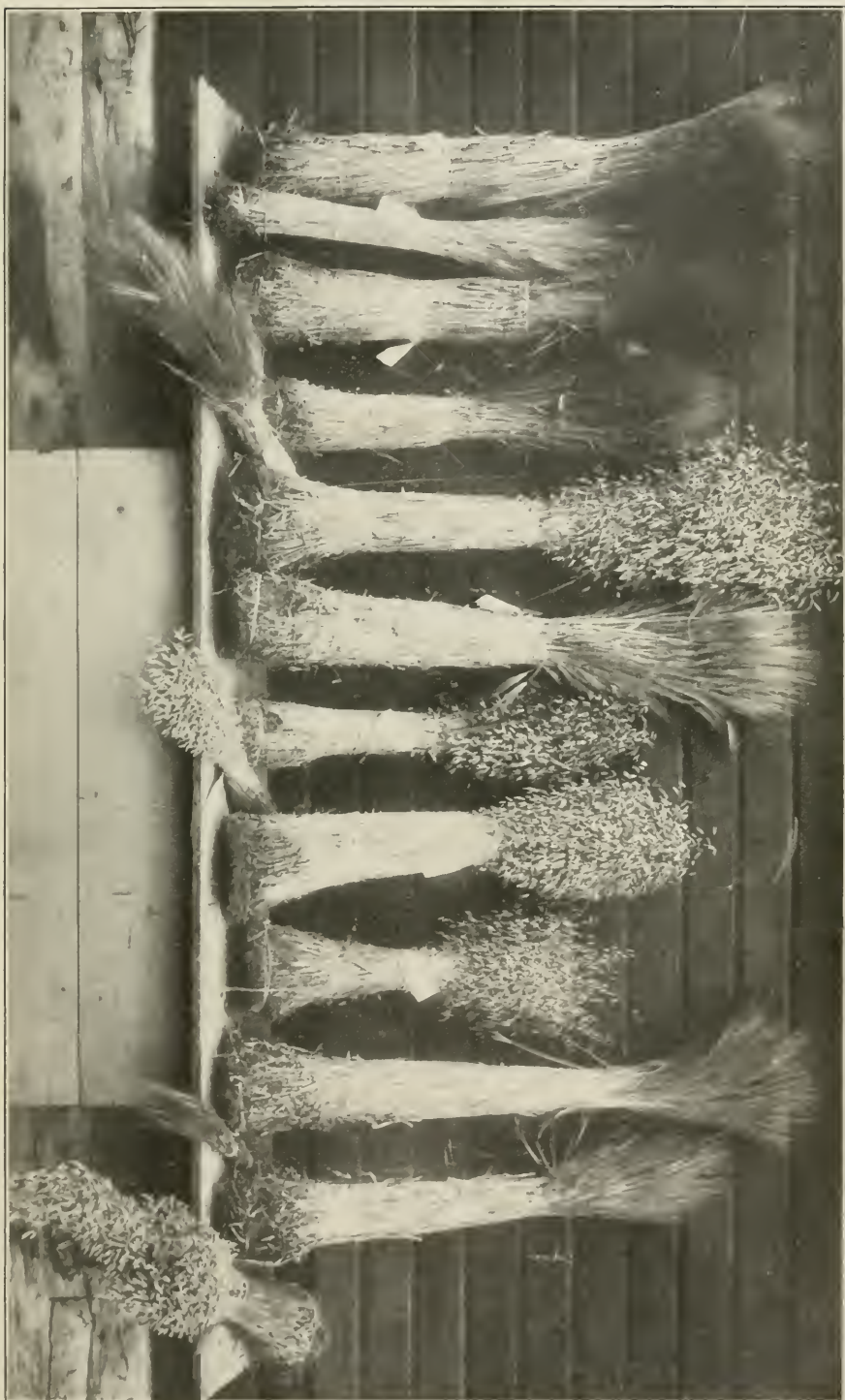
A team of horses was secured last fall from the U. S. Geological Survey through the kindness of Mr. F. C. Schrader, the chief of a party which had been operating in the Copper River country. This party used a number of horses, which were discarded at the close of the season, and Mr. Schrader turned two of the best over to Mr. Neal. These horses were fed in Valdez until trail work began in the middle of January. Mr. Neal then started to haul out the station equipment, consisting of two plows, a smoothing harrow, a disc harrow, a mower, a light wagon, a grain drill, a complete set of carpenter's tools, hand tools, spades, shovels, mattocks, hoes, rakes, scythes, forks, axes, etc.; also tents and camping outfit, feed for the horses, seed grain, provisions, and household effects for himself, aggregating about 4 tons in weight.

To move this outfit 105 miles over a rugged mountain chain through a country where there are no roads and where the snow was in places 15 to 20 feet deep, or even more, and the temperature most of the time from 10 to 30 degrees below zero was a formidable task, the hardships of which it is difficult to appreciate.

METHOD OF TRANSPORTATION.

A brief description of the present mode of hauling supplies into the interior is therefore pertinent. The snowfall on the Valdez side of the mountains aggregated 78 feet in depth last winter. It may readily be comprehended what it means to make a road through such a depth of snow. No one man with a team could make any progress at all, but by joining forces with many others it is made possible. All who have goods to move begin at the same time and cooperate. A force of men, with as many horses as are available, is sent ahead to break the trail each morning. They go as far as they can and return to camp by noon. They may make 7 or 8 miles or they may make 2 or 3, depending upon the depth of the snow and the nature of the ground. In the afternoon they hitch to their sleds and pull their goods over the broken trail until nightfall, when they make camp, and next morning the procedure is repeated. They cooperate in breaking trail, but the trail once broken each man hauls his own goods.

ALASKA STATIONS—SAMPLES OF BARLEY AND OATS GROWN AT UNITED STATES EXPERIMENT STATION IN THE COPPER RIVER VALLEY, SEASON OF 1903.



For hauling they use a style of sled which has been invented for the purpose. It is lightly but strongly built, 9 feet long and 30 inches wide, and about 1 foot high. The runners are rounded at both ends, so it can be pulled forward or backward with equal ease, and for this reason these sleds are usually styled "double-enders." The goods to be moved are securely strapped to these so that nothing falls out when they turn over, which they usually do many times a day. Where the ground is level and the trail has become firm one horse can pull two loaded sleds. Under less favorable conditions it takes a horse to each sled, and sometimes two. When a man has much goods to be moved he unloads his sled at the terminus of the broken trail and goes to the camp, reloads his sleds, hauls up this load, and so on again and again, until all the goods have been removed to the new camp.

The difficulties encountered can not be fully conveyed in words. The soft snow is packed down by the horses and sleds to a deep rut the width of the sleds, with walls on either side several feet high. The travel also wears holes in the trails due to the uneven surface. A loaded sled runs swiftly down a little incline and buries itself in the snow at the bottom. The hole thus formed is deepened by each passing load until the trail in many places becomes a succession of short hills and hollows, which taxes the draft animals greatly. These holes are usually referred to by freighters as "chuck holes."

The loaded sleds always have the right of way, and in going back empty the driver must pull into the soft snow to let the loads pass, and frequently horses sink in so deep that it takes hours to dig them out. The camps can not be far apart. If they are, there is danger that the trail will drift full and require breaking anew before the freight can all be hauled up. Mr. Neal spent three months with the team and one man to help him in moving the equipment from Valdez to Teikhel, 48 miles inland. At this point the horses gave out and could do no more. The season was now so far advanced that there was danger of the ice breaking up and making further traffic impossible, for the winter trail follows the streams and lakes as far as practicable because of the easier travel on the ice, and Mr. Neal was compelled to go to Copper Center very light and to hire the more necessary things hauled while the less necessary portion of the equipment was stored in tents at Teikhel.

The method of transportation here described is the only practicable one by which the interior can be reached with anything like large quantities of goods. Professional freighters charge 20 cents per pound for hauling goods from Valdez to Copper Center on the snow, and after investigating conditions I am satisfied that this rate of charge is not unreasonable.

In summer everything must be carried in on the backs of either horses or men, the rate then charged by freighters being 50 cents

per pound. Considering that it takes from eight to ten days to make the hundred miles with a heavily loaded pack train, that in the average condition of the trail a horse can not carry much over 200 pounds, and that horse feed, hay and oats alike, costs 25 cents per pound on the north side of the summit, this rate is not unreasonable.

THE TRAIL.

The trail is known as the United States military trail and was constructed by the War Department in 1898 and 1899. For some miles out from Valdez it is cleared about 12 feet wide, over level ground, and in dry weather is a very good road; but when the mountains are reached it narrows into a winding bridle path, the trees and rocks having been cleared away in places so as to make it passable for horses. Through Keystone Canyon a very excellent piece of trail has been constructed by blasting a path along the side of the mountain for a distance of 4 miles. Considerable work has also been done in bridging the larger streams and in making a zigzag path up the deep sides of Stewart Divide. The trail as it now exists is of very great value in the development of the interior, and in dry weather it can be traveled with comparative ease; but after heavy rains it abounds in mudholes, making it well-nigh impassable.

The summit of the mountains is reached some 20 miles from Valdez. In summer time it offers no great obstacle to traffic, as it is not a steep climb, but in winter the frequent and severe storms and deep snow on the summit render the passage at times dangerous. The Stewart Divide, which is rather a steep ridge some 40 miles from Valdez, is much more difficult to climb, because it is steeper, the trail having to zigzag in places to reach the top of the sharp ridge. The winter travel follows the streams around this ridge. Aside from these two elevations there is no arduous climb to make, but the traffic over the low places where horses sink to their bellies in mud is even more laborious than to go over the hills, and crossing some of the streams which are not bridged is dangerous when the water is high.

THE COPPER RIVER COUNTRY.

The valley of the Copper, speaking in general terms, is a basin surrounded on all sides with mountains. It has an area of about 10,000 square miles, which will have more or less value as farming and grazing lands.

The streams tributary to the Copper have also valleys of considerable extent, and afford equally good farming land. At a conservative estimate these tributary valleys will have an area of 5,000 square miles of more or less valuable agricultural land, or a total area of 15,000 square miles.

The floor of the main valley is arranged in a succession of benches, or large terraces, which rise abruptly one above the other toward the north, varying in height from 100 to 200 feet, or even higher. Each bench is comparatively level on top and comprises an expansive area. Parallel with the Copper is another system of benches of the same formation but not so wide. At the mouth of the Klutena, where the experiment station is temporarily located, these benches vary from a quarter of a mile to a mile or more in width.

The whole country was nearly covered with spruce forest, but extensive fires destroyed it over large areas many years ago. Here and there willow thickets have sprung up since the fires, but everywhere the dead and charred trunks are standing or lying on the ground. This land is comparatively easy to clear, and it affords an abundance of good, dry fuel for the use of settlers. This dead timber is small, most of the trees not being much larger than large telegraph poles, but some of the live timber is comparatively large.

The soil is generally a light loam, that is, of a more or less sandy or gravelly nature, but in low places it is rich in humus and occasionally peaty. The subsoil, so far as the writer had opportunity to examine it, was found to contain a large amount of a coarse gravel, and the surface loam varied from 6 inches to 2 feet in thickness. This formation while a "warm" soil, and therefore favorable to a rapid growth, will also be liable to suffer from drought and, so far as our data at present available will enable us to judge, the early part of the season throughout the Copper Valley is deficient in rainfall. The writer is informed that there are also extensive areas with a clay subsoil, and it is a question which is the more preferable, the gravel or the clay; the former being warm but lacking in moisture, the latter being cold but suffering less from drought.

Nine acres had been cleared and seeded to many varieties of grains, grasses, and vegetables. At the time of my visit the grains were still small, most of them not having headed, but as an example of the rapid growth in this region, the barley and oats were ripe four weeks later. More ground was being cleared and next year the station will have 16 acres in cultivation. Some of the grains promised well, others were stunted. It was noticeable that wherever the ground had been fertilized by the ashes of a burnt brush heap the growth was very much more vigorous than in places not thus fertilized.

Vegetables promised well. Turnips, radishes, and lettuce had been in use for some time, and peas were ready for the table by the middle of July.

Mr. Neal is an enthusiastic, industrious, and careful worker, and he deserves much credit for the results accomplished.

The team of horses owned by the station is worn out and was not considered worth wintering, inasmuch as the cost of keeping a horse

through the winter months is almost equal to his original cost; therefore Mr. Neal was authorized to dispose of this team to best advantage, and to select a stronger and heavier team, which had not been injured by packing on the trail, to take their place. Such a team has been found and we have made arrangements to have it wintered at Valdez, for the reason that trail work begins at that end, and we have still some equipment to haul in and it is impossible to bring a single team from Copper Center to Valdez until the trail is broken.

The writer left Valdez on July 13 and arrived at Copper Center, the name given to a few cabins located at the junction of the Klutina with the Copper, on July 18, the trip taking six days, which is about the average time. The station clearing is located about three-fourths of a mile north of Copper Center, on the first bench. (Pl. VI, fig. 1.)

I consider the soil on the station too light and too thin to stand continuous cropping for very many years, and for this reason I selected a tract of land of a stronger nature, located about midway between Tonsina Bridge and Copper Center, for possible future use. The lines run east and west for 2 miles along the shores of an unmaned lake and north and south for 1 mile, so that it comprises about 2 square miles. A large portion of it has a gentle slope southward toward the shores of the lake. The soil is a light but rich loam, and the subsoil is a porous clay carrying considerable gravel, but will not be likely to suffer greatly from drought. I recommend that this selection be withheld from settlement temporarily, until the building of the railroad shall decide where the permanent station had better be located. In the meantime it would appear best to continue work at the present location at Copper Center. There are many thousand acres of land of similar character, and we ought to ascertain what its value is for agricultural purposes.

I recommend that the work of clearing, breaking, and bringing under culture be pushed with vigor until the station has a hundred or more acres under plow, in order that we may test grain growing on a scale which shall give us decisive results. To do this will necessitate the hiring of much labor for a year or two, and it must not be forgotten that common labor costs \$5 per day.

I would not recommend the erection of more buildings than are absolutely necessary, and these should be of an inexpensive character, built from the material at hand.

ECONOMIC CONDITIONS IN THE COPPER RIVER VALLEY.

The present high cost for transportation of all of food supplies and all other necessary articles makes living very expensive. As an example of the cost of some common commodities I quote the following prices:

Flour, per 50-pound sack, \$15; ham and bacon, per pound, 40 cents; canned meats, per can of 2½ pounds, \$1; canned milk (Eagle), per can,



FIG. 1.—ALASKA STATIONS—SITE OF COPPER CENTER STATION.



FIG. 2.—ALASKA STATIONS—FIRST STATION BUILDING IN COURSE OF CONSTRUCTION AT COPPER CENTER.

75 cents; tea, per pound, \$1; coffee, per pound, 75 cents; sugar, rice, beans, sago, dried fruits, corn meal, and oat meal, per pound, 35 cents; sardines, oysters, and deviled ham, per can, 50 cents; lunch tongue, per can, 75 cents; potatoes, sliced and dried, per pound, 50 cents; salt, 3 pounds, \$1; hay, per pound, 25 cents; oats, per pound, 25 cents; kerosene, per 5-gallon can, \$10.

These prices are due to the cost of transportation. The further one goes inland the higher the cost. There are no regular stores beyond Copper Center and there are therefore no fixed values.

Game is becoming scarce and beef or mutton can seldom be had, and therefore have no fixed prices. The writer learned on the best authority of instances which illustrate the situation in this regard. A steer was bought in Valdez for \$125. The purchaser put a pack of 250 pounds on his back and drove him to a mining camp in the Slate Creek district along with a train of pack horses. He received \$1 a pound, or \$250 in freight for the goods the steer carried. He then slaughtered him and sold the meat for \$1 a pound. On the other hand, a dozen steers were driven into the camp on the Nizina, 200 miles distant, the past summer, but there was no demand for this meat, and they had to be driven back to Valdez and sold at local prices.

The prices of hay, oats, and other farm products are attractive to farmers, and there is no doubt whatever but that money can be made in producing these things if the farmer is once established, has his farms cleared up and in running order. The question is if the necessary outlay to get this start will not exceed the means of the class of farmers who are likely to settle in the Copper River Valley. In the first place, the cost of landing his goods and family in Valdez is considerable, but leaving this out of account the cost of transporting his equipment, say as far as Copper Center, is almost prohibitive if he has to hire it done, and it will be high even if he can do the work himself. He should carry with him a year's provisions, considerable feed for his live stock, the necessary implements and seed grain, and, if he has a family, also some household goods. If he can reduce the equipment to 5 tons, or even 4, it will cost him 20 cents per pound, or from \$1,600 to \$2,000 to land his goods in the farming region, about 100 miles from Valdez. If he can do it himself with his own animals, and he does not consider the labor and hardship involved, it will, of course, cost him only the price of provisions and feed, sleds and other necessary equipment for the trip, and the labor he will find necessary to hire to help him over the hard places. In that case no estimate can be put on the cost, but it will be some hundred dollars at least.

The natives of the region seem to be inferior to the Indians on the coast in physical vigor and general thriftiness. They complain bitterly that the white man scares the game away, and that furs are also becoming scarce. Unless they learn to work and earn wages, to cultivate gardens, and acquire habits of greater thrift, they must inevitably

succumb. At present they live almost wholly on salmon, and fortunately this year the run of salmon was good, so they have laid in a good store for winter.

A WAGON ROAD NECESSARY.

Confronted by these facts, it does not seem likely that even the Copper River Valley, which is, perhaps, the most promising agricultural region in Alaska, can be settled very fast. But a good wagon road would solve the problem. The settler could then make his move in summer. He could then hitch his plow horses to his own wagon at the wharf in Valdez, and drive in at his leisure, grazing his live stock on the road as he went. The cost would then be represented chiefly by his own time and labor; and he could then make several trips until all his goods were transferred to the homestead of his choice, but until a wagon road is provided this is impossible. Now, it is not likely that such a road will be built by private enterprise. To get returns on the investment a private road would be compelled to charge toll, and the building of a railroad, which must eventually come, might deprive it of much traffic. A Government road is necessary to settle the country, and in my opinion it will pay the Government richly to build such a road.

Here is a region which will give homesteads to 30,000 families. It is analogous to a man owning a valuable piece of real estate which must be made accessible before he can dispose of it. If the region were owned by capitalists and they desired to have it settled they would not long consider the question of making it accessible. The returns to the Government would be the building of a State, enlarging its productive territory, and providing homes for its citizens, which are the proper and legitimate causes for expenditure.

The cost of building a good wagon road will depend upon the way the work is handled. By utilizing the work already done on the military trail \$100,000 should go very far toward making a good road. In many places there is a hard natural roadbed, which would require but little work; in other places, where the ground is soft, it would be more expensive; but there is an abundance of timber in those places, and rocks are at hand everywhere. The somewhat rude log bridges, which now span the larger streams, can be made to last for years if they are watched and repaired when they need it. In a few places the route will deviate from the military trail in order to follow easier grades and to select firmer ground, and in a few places it will be necessary to blast out a roadbed, but on the whole the task is not a formidable one.

A wagon road is necessary, even if a railroad is built. The tariff on a railroad, without competition, in a new country will not be light, and if there is no other means of reaching the country freight rates

will keep many settlers away. A wagon road will make the people in a measure independent.

Attention is called to Mr. Neal's report, herewith submitted, and also to the weather conditions and soil temperatures recorded at this station during the past year.

REPORT OF J. W. NEAL, SUPERINTENDENT OF COPPER CENTER STATION.

COPPER CENTER, ALASKA,

September 10, 1903.

DEAR SIR: I herewith submit the report of the season's work for 1903, confining my notes strictly to the crop experiments and station work generally.

Receiving the station equipment at Valdez, I began moving the same over the snow and ice toward the Copper Center Station January 20, employing one man from February 1 and some additional help at Teikhel. The trip proved long and arduous. We arrived at the station April 26 with most of the equipment, including all the seed and most necessary implements to prosecute the season's work.

At this date the weather was warm and the snow leaving very fast. On May 1 the snow had entirely melted off the 9 acres which we had cleared ready for the plow, and by May 8 the frost was sufficiently out of the ground to begin plowing and cultivating the soil. Notwithstanding the fact that our team was almost exhausted by the long stage of freighting, the soil new and full of roots, and a limited supply of feed, we had 5 acres ready for seeding by May 19, and on May 20 we had seeded plats of every kind of seed at hand.

While the snow was leaving and frost getting out of the ground we turned our attention to clearing. After the seeding was finished we built about 1 mile of fence, inclosing some 40 acres. We then began to get out timber and laid the foundation for a log cabin 16 by 24 feet, exterior dimensions (Pl. VI, fig. 2). Leaving for Valdez July 2 to meet the special agent in charge, I set the workman to clearing land for such time as he could leave the growing crops. At this time I hired a native at \$3 a day to help in clearing, but natives soon tire and he left us after five days. No other help was then available.

After my return from the trail I succeeded in hiring a white man for a few days at \$5 per day, and we resumed work on the cabin, but he soon left us and I had to turn my attention to the crops, collecting grain samples, cutting some frosted wheat for hay, and reaping and thrashing the barley and oats which matured excellent grain. At the close of my report the cabin is up, ready for the roof, which we expect to put on before the snow flies. We will have to store the hay and implements in tents for want of time to erect sheds.

Aside from the 5 acres seeded May 19 and 20, we seeded some 4 acres a few days later. We have added to our clearing some 6 acres,

which will be broken this fall and prepared for spring seeding. Have rebroken 2 acres of the spring cultivation and seeded the same to winter wheat with a 10-press drill. This grain is up and growing well.

WEATHER CONDITIONS.

During the fore part of the season the weather conditions proved very unfavorable this year, there being an excessive amount of snow-fall all over the valley and a late spring, together with a very light rainfall during the early summer; the crops made a late start and suffered an early fall.

The temperature fell below 30° F. every month during the summer. In May the minimum temperature was 23° F., falling to 32° F. 15 days in the month; in June falling to 32° F. and under on 3 days; July 12 to 29° F., killing some tender plants and rye then in blossom, and August 30 to 24° F., falling to 30° F. on the 26th, frosting hard every night thereafter save one, and hard frost continued up to the 6th of September.

The barley and oats had matured before these heavy frosts, but the wheat suffered. With eight or ten days' more favorable weather the wheats would have matured fully.

Comparing notes with last year, the minimum for July was 38° F.; August, 28° F.; with no killing frost up to September 15. Under these conditions every variety of wheat would have matured and been in the sack before September 15.

Barley and oats have matured at Copper Center every year since 1900, and while wheat had not been planted up to this year I saw one head last season which, having escaped the loose stock on the trail, matured plump, hard grain.

NOTES ON FIELD CROPS.

Barley.—Trooper 6-rowed, seeded broadcast May 20. Surface soil dry and no rain until June 1. Coming up June 5. Stand good. Growth slow and rather poor. June 25, 9 inches high; a little irregular in growth. July 15, 16 inches high and heading. July 20, a few heads of smut appeared. August 10, 2 feet high. August 24, fairly matured or past danger of frost. The heads were small, but well filled. A small plat was seeded May 22 in drills on moist soil. Came up in 10 days. In full head stood 3 feet high, and heads good size, well filled, and matured by August 27.

Sisolisk, seeded May 20. Coming up June 5. Stand good. Growth rather poor. June 25, 8 inches high. July 15, 15 inches high and heading. July 20, about all headed out. Growth very irregular. August 10, 2 feet high and straw turning. August 25, well matured and grain quite hard. On the portion of this plat where a brush heap



FIG. 1.—ALASKA STATIONS—FIELD OF RIPE MANSHURY BARLEY AT COPPER CENTER STATION.



FIG. 2.—ALASKA STATIONS—CUTTING RIPE MANSHURY BARLEY WITH MOWER AT COPPER CENTER STATION.

had been burned the grain made a rank growth, standing 3 feet high when ripe. Matured the same time, heads good size and heavy.

Royal, seeded May 20. Coming up June 5. Stand good. On one half the plat the growth was poor, the other half good. June 25, 8 inches high. July 15, 18 inches high and signs of heading. August 10, 3 feet high and straw turning and grain passing into the dough. August 25, the greater portion had matured or safe from frost. August 27, frost injured portions not quite matured. This variety was next to the last to ripen.

Finnish, seeded May 20. Coming up June 5. Stand good. Growth rather poor on the greater portion of the plat, but where a brush heap had been burned the grain stooled well and made a very rank growth. June 25, 14 inches high. July 15, 2 feet high. July 25, well headed out and nearly 4 feet high. August 10, straw yellow and grain in dough. August 25, well matured and grain quite hard. One of the first varieties to ripen. Heads large and heavy. The same in drills did no better.

Manshury, seeded May 20. Coming up June 6. Stand good. June 25, 13 inches high. July 15, nearly 2 feet high and heading. August 10, $3\frac{1}{2}$ feet high and grain in the dough; straw turning. August 25, grain quite hard and well matured. Heads good size and well filled. One of the first varieties to ripen. This variety stooled very well, 6 heads from kernel not uncommon. (Pl. VII, figs. 1 and 2.)

Lapland, seeded May 20. Coming up June 7. Stand good. June 25, 13 inches high on better portions of the plat. This variety, as all others, made much better growth wherever brush or logs had been burned in heaps. July 15, $2\frac{1}{2}$ feet high and heading. August 10, $3\frac{1}{2}$ feet high, straw turning, and grain in the dough. August 25, grain quite hard and well matured. Heads large and well filled. This was one of the earliest varieties to mature. The Lapland, Manshury, and Finnish may be highly recommended for the Copper River Valley. All of these stooled well, 5 to 7 heads to a single kernel not uncommon.

No. 9133, two-rowed, seeded May 20. Coming up June 7. Stand good; growth poor. No brush burned on this plat. June 25, 6 inches high. July 20, 15 inches high and heading. Stooled very little. August 10, 20 inches to 2 feet high, and grain in milk. August 25, portions of the grain fully matured. Heads fair size and well filled. This variety was about the last to mature, and killing frost August 27 injured portions yet unmaturing. A small plat seeded May 22 in drills by hand made better growth, but had not matured when killing frost came, August 27.

Black Hulless, seeded May 20. Coming up June 6. Stand good. Growth rather poor. Stooled a little. No ash heap on this plat. July 15, 16 inches high and beginning to head. August 10, 2 to $2\frac{1}{2}$ feet high. Heads small, but grain large and in dough. August 25,

grain hardened and safe from frost. Matured fully. A small plat drilled by hand May 22 made better growth and much larger heads, but only about half of this plat had matured August 27, when killing frost came and damaged the remainder of the crop. The large plat all matured. The small plat stooled well, 5 to 7 heads to the plant.

Oats.—Sixty Day, seeded broadcast May 20, as the barley. Coming up June 5. Stand good. Growth very good on portions of the plat where brush was burned. Rather poor elsewhere. July 1, 12 inches high. July 15, 20 inches high and heading. August 10, the best stood 3 feet high, heads well filled, and grain in the milk. August 25, grain matured and hard; yield good. (Pl. VIII, fig. 2.)

No. 2800 (from Russia), seeded May 20. Coming up June 7. Stand only fair. Growth poor. No brush burned on this plat. July 1, 9 inches high. July 15, 18 inches high and heading. August 10, the best was 2½ feet high and grain half formed. August 25, the greater portion still green and grain in the dough. When killing frost came, August 27, portions of the grain was yet soft enough to be frozen, but the greater part matured. This variety was the last to ripen.

Nameless Beauty, seeded May 20. Coming up June 6. Stand good. Growth rather poor. No brush burned on this plat. Stooled very little. July 1, 8 inches high. July 15, 18 inches high and heading. August 10, best portion 2½ feet high and grain nearly out of the milk. August 25, grain nearly hard and straw quite yellow. Matured fully.

Finnish Black, seeded May 20. Coming up June 6. Stand good. July 1, 14 inches high. July 15, 2 feet high and heading. August 10, on all portions of the plat where brush had been burned the oats stood 3½ to 4 feet high, and long, heavy heads. August 25, grain well matured and heads hard.

Burt Extra Early, seeded May 20. Coming up June 6. Stand good. July 1, 14 inches high. July 15, 20 inches high and heading. August 10, the best 3 feet high. August 25, matured and grain quite hard.

Swedish Select, seeded May 20. Coming up June 5. Stand good. Growth poor. July 1, 6 inches high. July 15, 12 inches high. Not heading. Two or three small spots, evidently where stumps had been burned, did much better. July 15, 20 inches high and well stooled. Not yet heading. August 10, 3½ feet high. Had headed out well. August 25, grain pretty well matured. Next to the last to mature.

Of all the oats, Sixty Day and Finnish Black did the best.

Wheat.—Ladoga Spring, seeded May 20. Coming up June 5. Stand good. Growth rather poor, except where brush had been burned. June 25, 12 inches high. July 15, 20 inches high. Heading July 20. August 10, 3 feet high and some patches over 4 feet high; heads large and well filled. August 25, grain nearly out of the dough. August 27, heavy frost damaged, preventing the grain from thoroughly

maturing. The straw ripened well, but the grain shriveled and the germ was killed. This variety stood out well.

Roumanian, seeded May 20. Coming up June 5. Stand good. Growth poor, except on brush-burned portions. Here the growth was rank and stood well. June 25, 14 inches high. July 15, 2 feet high and heading. August 10, 3½ feet high; grain half formed. Poorer portions stood 2 feet high and about the same stage. August 25, grain nearly past the dough and straw yellow. August 27, frost damaged, killing the germ and causing the grain to shrivel. This variety was almost beyond danger and the furthest advanced of all varieties grown.

Kubanka Spring, seeded May 20. Coming up June 5. Stand good. June 25, 12 inches high where brush had been burned. July 20, 2 feet high and heading. Other portions 15 inches high and heading. August 10, the best stood 4 feet high, well headed and grain over half formed; heads large. The poorest stood 2 to 3 feet high; heads small. August 25, grain well in the dough and kernel large; straw quite yellow. August 27, frost injured, killing the germ and causing the grain to shrivel. The straw ripened fully by September 10.

Russian Spring No. 2955, seeded May 20. Coming up June 6, stand rather poor. July 1, 8 inches high. July 15, 12 inches high. Begun heading July 20. August 10, the best 3 feet high and blossoming. August 25, in the dough; straw quite green. August 27, frost injured, grain shriveled. The straw ripened by September 10.

Pererodka Spring, seeded May 20. Coming up June 5, stand medium, growth poor generally, but on brush-burned portions good. July 1, 10 to 18 inches high. July 20, the best stood 2 feet high and heading. It stood well. August 10, 4 feet high and blossoming; heads large. Other portions 3 feet high and heads smaller. August 25, grain in the dough and straw turning fast; grain large. August 27, frost injured, killing the germ and causing grain to shrivel; straw fully ripe by September 10.

Russian (Orenburg) Spring, seeded May 20. Coming up June 5, stand good. Growth poor except where brush had been burned. July 1, 9 to 15 inches high. July 15, the poor stood 15 inches high, the best 2 feet. Begun heading about July 20. August 10, the best 4 feet high; stood well and heads large. August 25, in the dough and straw turning fast. August 27, frost injured, causing the grain to shrivel.

Romanov (imported seed), seeded May 20. Coming up June 5, stand very good. No brush burned on this plot. July 1, 10 inches high. July 15, 12 to 16 inches high and begun heading. August 10, 2 to 3 feet high and grain half formed. August 25, well in the dough and straw turning fast. August 27, frost injured; straw ripened by September 10, grain shriveled.

Romanow (Sitka seed), seeded May 20. Coming up June 6. Stand

very good. Like all the grains, this variety made rank growth wherever brush or logs were burned and stooled very good. July 1, 15 inches high. July 20, 20 inches to 2 feet high and heading. August 10, the best stood $3\frac{1}{2}$ feet high, and grain half formed. August 25, grain in the dough and straw quite yellow. August 27, frost injured, causing grain to shrivel. Roumanian, Romanow, and Kubanka seemed the farthest advanced when the killing frost came. Ladoga was the most backward, but had the season been as last year even this would have matured.

All the above grains were seeded broadcast when the surface soil had become dry through spring cultivation, and the seed lay without any signs of germination until a shower came June 1. Could we have had this shower one week earlier our wheats would no doubt have matured before this unusually early frost.

All the winter wheats seeded last fall were winterkilled, or eaten up by the rabbits as the snow left. The winter rye was bitten off into the ground, but each variety survived in some measure, making a growth of from 4 to 6 feet high, but a frost July 12 killed the grain in the blossom. The straw remained quite green at the writing of this report. Spring seeding did no better and matured no seed.

Emmer.—Yaroslav Spring, seeded May 19. Coming up June 5, stand good; growth very good. July 1, 12 inches high. July 20, 20 inches to 2 feet high, and heading. August 10, $3\frac{1}{2}$ to 4 feet high and grain half formed. This plat made quite even growth and stooled out well. August 25, grain in the dough and straw turning fast. August 27, frost injured the grain causing it to shrivel. The straw was quite ripe September 10. (Pl. IX, fig. 2.)

Uba Spring, seeded May 19. Coming up June 5, stand good. Growth good and regular. July 1, 10 inches high. July 20, 18 inches high and heading. August 10, 3 feet high and grain half formed. August 25, grain in the dough and straw turning. August 27, frost damaged the grain badly. The straw ripened pretty well by September 10.

Russian Spelt No. 2789, seeded May 19. Coming up June 6, stand poor. July 1, 6 inches high. July 20, 12 to 15 inches high, and beginning to head. August 10, $2\frac{1}{2}$ feet high and blossoming. August 27, grain not fully formed when frost came; straw yet green.

The emmers were all seeded broadcast in dry surface soil and no signs of germination until rain June 1. Yaroslav and Uba would have matured with a season as last year.

Buckwheat.—Japanese, seeded May 19. Coming up June 5, stand good. July 1, 12 inches high. Growth thrifty and plants branching good, blossoming July 12, when frost killed all the plants.

Finnish, seeded May 19. Coming up June 5, stand very good. July 1, 8 inches high, branching and beginning to blossom. July 12,



FIG. 1.—ALASKA STATIONS—SHOCK OF MANSHURY BARLEY AT COPPER CENTER STATION.

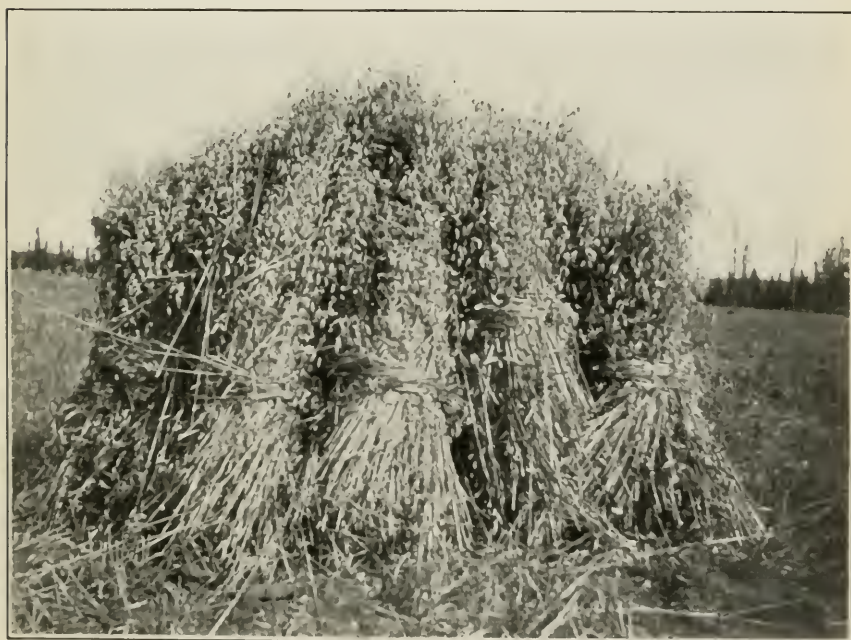


FIG. 2.—ALASKA STATIONS—SHOCK OF SIXTY-DAY OATS AT COPPER CENTER STATION.



FIG. 1.—ALASKA STATIONS—DRILLING WINTER WHEAT AT COPPER CENTER STATION.



FIG. 2.—ALASKA STATIONS—YAROSLAV EMMER NEARLY RIPE AT COPPER CENTER STATION.

frost cut the plants back. Some low branches escaped and continued to grow and blossomed. July 20, 10 to 15 inches high. August 10, some seed had formed and in the milk. This was thoroughly matured by August 20.

Silver Hull, seeded May 19. In hand drills on soil spaded up last year. Came up in 14 days, stand good. This variety matured good seed and a fair yield. The plants stood $2\frac{1}{2}$ feet high and quite well branched out. It was seeded on higher ground than the other varieties and seemed to escape the frost of July 12.

Flax.—A large patch was seeded broadcast May 20. Came up June 7; a little thin on the ground. July 20, 20 inches high and blossoming. August 10, much of the crop stood 30 inches high; seed pods well formed; many flowers continued to appear. The first seed ripened about August 25. Only a small per cent of the seed was ripe at the close of report, September 10.

Peas.—A good-sized patch was seeded broadcast May 20, but the soil being so dry they did not come up until after a rainfall June 1, coming up June 6. July 20, $2\frac{1}{2}$ feet high and blossoming. August 10, pods set and peas half size. August 27, frost injured so much that no seed matured. The vines were cut and fed to a cow as a test for feeding qualities. They were eaten with much relish, and there was a noticeable richness in the flow of milk.

Grasses.—The following grasses were seeded broadcast May 19. The soil on the surface was very dry until June 1, when a rain came. Most varieties germinated quickly after the rain and began to appear above the surface in four or five days. In some instances the seed was not good, but on the whole the plats showed rather a satisfactory growth. The conditions throughout the season were noted as follows:

Timothy made a fine stand; a little uneven in growth. July 20, 8 inches in growth and ground pretty well hidden. August 10, 24 to 30 inches tall and well headed out. September 10, still very green and a good sod formed. No seed had formed.

Redtop made a very slow growth, but a good stand. July 20, 6 inches growth and ground pretty well covered. By August 1 it had begun heading, 10 to 11 inches high. August 10, 13 to 18 inches high. September 10, still quite green and had formed a very good sod. No seed had formed.

Orchard grass made an excellent stand, and well set by July 20; 4 to 6 inches growth and the ground well covered. August 10, showed very little difference in growth, but looked thrifty. September 10, looking a little yellow and no signs of heading.

Meadow foxtail made a very slow growth; stand rather poor. July 20, 3 to 6 inches growth. August 10, a very little change in growth and appearance. September 10, still about the same. It did not make any stems.

Blue grass made a slow growth and poor stand. July 20, 2 to 4 inches growth. August 10, 8 to 12 inches high; had thrown out a few stems, and heading. September 10, still green, but no more growth. No seed had formed.

Tall meadow-oat grass made a splendid stand. July 20, stood 12 inches high; ground well covered. August 10, 8 to 22 inches high and heading. September 10, still green; chaff matured, but no seed formed.

Tall meadow fescue made a slow growth at first. July 20, 4 to 9 inches growth and the ground well covered. August 10, some stems were thrown out and headed, standing 30 inches high. September 10, the grass was still green; the chaff matured, but no seed formed.

Smooth brome grass made a splendid stand. July 20, 6 to 12 inches tall; rank growth, thoroughly covering the ground. August 10, 20 to 24 inches tall and beginning to head. Before the next observations were taken some stock broke into the field and ate the tops off nearly the whole plat. However, a few stalks headed, standing 3 feet high, but still green September 10.

Perennial rye grass made a very good stand. July 20, 8 to 10 inches high and thoroughly matted. August 10, some heads appeared, standing 12 to 15 inches high, and growth even more matted together. Before the next observations were made some stock that broke into the field ate this plat off close to the ground, and a new growth seemed to be starting September 10.

Red clover and alsike clover were likewise seeded near the above grasses. The alsike clover made a light and rather unsatisfactory growth, but still green September 10; slightly frosted. The red clover made much better growth. It made a good stand. July 15, 4 to 6 inches growth, pretty well covering the ground. August 10, 12 inches high and a few blossoms appeared. September 10, still green, but slightly frosted. No seed formed. I found some plants along the military trail 18 to 20 inches high, stalks thrifty, and in blossom by the end of July.

Dwarf Essex rape seeded May 19, broadcast; stand good. Frost injured July 12. The plants then covered the ground, but making a poor growth, standing 6 to 10 inches high. August 1, some stalks on brush-burned soil, uninjured by frost, stood 15 to 18 inches high; leaves 8 to 9 inches across. It did not seem to grow much after this time.

VEGETABLES.

Most of the common, hardy vegetables were grown at the station this year; but the ground being new and with only 4.31 inches rainfall from May 1 to the end of the growing season, the results were, in part, rather unsatisfactory. The varieties grown were enumerated as follows:

Cabbage (Early Jersey Wakefield), *cauliflower* (Early Snowball), and *tomatoes* (Livingston Perfection).—These were seeded in boxes and

planted on a temporary hotbed the first week in May, which was late, of course, but unavoidable, owing to my being absent from the station at the proper time for seeding the same. These were transplanted to the garden June 15, and while none came to any good the cabbage had begun to head by the end of August. The cauliflower showed no sign of heading. The tomatoes were growing finely when killed by frost, July 12.

Peas.—Little Gem and Earliest of All. These were seeded in drills 18 inches apart May 14, and both gave good results. Earliest of All came up in 12 days, and the first blossoms appeared June 25, 42 days from seeding. Pods were setting by June 30, and the peas were ready for table use by July 18, 65 days from seeding.

Little Gem began to blossom July 10, 57 days from seeding. Pods were setting July 20, and the peas were ready for table use by August 10, 88 days from seeding.

Lettuce.—White Winter Cabbage, Big Boston, and Early Curled Silicia were seeded in drills 12 inches apart May 14. The surface soil was very dry, but most of the seed germinated, coming up in 9 to 16 days. White Winter Cabbage seed was poor: only about 10 per cent grew. This variety was ready for table use July 1. Big Boston variety was ready for table use June 28. It made a thrifty growth; lettuce crisp and delicious. The plants attained a very large size by midsummer. Early Curled Silicia variety was ready for table use June 28. It made a thrifty growth; lettuce crisp and delicious, and preferable to all other varieties grown on the station.

Onions.—Extra Early Red and Australian Brown were seeded May 14, coming up in 12 to 17 days. Only about 10 per cent of the seed germinated. The soil was very dry, and not rain sufficient to give them a fair test. By fall they had only attained the size of large marbles. The Early Red did the best. A quart of sets had been mailed to me at Valdez during the early winter and then were frozen as I carried them in over the snow and ice, so that only a few sets grew. These only made a fair size, but quite fit for table use. They were pulled and laid away September 10. The tops were then dry.

Garlic.—Three bulbs accompanied the onion sets and were set out the same time, but none started.

Radish.—Early Scarlet Turnip and Early Long Scarlet were seeded May 14. The former was ready for table use June 26, then the size of walnuts. They were sweet and crisp. The latter did very well; ready for use a few days later.

Carrots.—Guerande, or Ox Heart, and Early Scarlet Horn. The season kept too dry for these as well as all the vegetables. The carrots did only fair, making roots 1 to 1½ inches in diameter. Very little noticeable difference in the varieties.

Turnips.—Early Flat White Dutch, Extra Early White Milan, and

Purple Top Strap Leaf were seeded May 14. They came up in 7 to 10 days, and all made about the same growth. The roots were a little small, but crisp and juicy, and certainly very fine.

Ruta-baga.—Yellow Swede, seeded May 14, came up in 7 days. It made good-sized roots, sweet and crisp.

Parsnips.—Large White Dutch, or Sugar, seeded May 14 and 22, came up in 12 to 16 days. It made roots about 1 inch in diameter, and roots run deep.

Beets.—Golden Tankard and Dark-Red Egyptian Turnip, seeded May 14 and 25, came up in 11 to 14 days. The first variety mentioned made a thrifty top growth, and some beet roots measured $2\frac{1}{2}$ inches in diameter. Egyptian Turnip did only fairly well, the best beet roots measuring 2 inches in diameter. These, when prepared for the table, were eaten with a relish.

Rhubarb.—Victoria, seeded May 14 and 23, came up in about 22 days. Only a few seeds grew. These only made small plants this year.

Beans.—Detroit Wax and Windsor, seeded May 14. Each variety came up in about 22 days. A frost July 12 killed the Detroit Wax and injured the Windsor slightly. The latter remained green and formed a few pods. These were late in filling, and frosted August 27. No seed matured.

Chérril.—Curled; seeded May 23; none grew.

Kale.—Dwarf Curled Scotch, seeded May 14 and 23, came up in 9 to 15 days. It was large enough for table use July 5.

Cress.—Curled or Pepper Grass, seeded May 14 and 23, came up in 7 to 10 days. It made a good growth, and was ready for table use by June 30. It made stems over 2 feet tall and ripened a heavy crop of seed.

Potatoes.—We can not say much on this subject as yet. The great problem is to get seed here in time for planting. Arrangements were made with James Fish, at Valdez, to send us one horse load of seed last spring, but by the time horses could be taken over the summit it was too late and the seed was not sent. However, a Mr. Holman paid a prospector \$5 for packing 3 pounds of potato eyes to Mr. Blix, his partner at Copper Center. One-half of these were given to us to plant at the station. These were planted after the middle of June, and only 4 eyes grew. They came up about July 1 to 5, and made quite a good growth. Frost killed the vines August 27. At that time the tops were about 9 inches high and the tubers the size of large hen's eggs. I found as high as seven of these, with some small ones, to a single hill.

It is very evident that as the ground becomes older settlers can raise vegetables for home use without difficulty, and with irrigation they can grow vegetables of the finest order.



FIG. 1.—ALASKA STATIONS—BREAKING NEWLY CLEARED LAND AT KENAI STATION.



FIG. 2.—ALASKA STATIONS—GRAIN GROWN IN 1903 AT RAMPART, LATITUDE 65° N.



FIG. 1.—ALASKA STATIONS—PATCH OF BUCKWHEAT IN BLOOM AT KENAI STATION.



FIG. 2.—ALASKA STATIONS—FIELD OF BURT EXTRA EARLY OATS AT KENAI STATION.

Among our present needs I will recommend as much needed at this station a good hay rake and at least 10 bales of barbed wire. The latter is a serious need to protect our crops. The ordinary pole fence does not turn the stock once they get a taste of the fine oats and various grains growing at the station.

Respectfully submitted.

J. W. NEAL,

Superintendent Copper Center Experiment Station.

Prof. C. C. GEORGESON.

Special Agent in Charge of Alaska Investigations.

KENAI STATION.

On returning to Valdez from the interior I took the first boat bound for Cook Inlet, which happened to be the *Newport*. She left Valdez August 11 and arrived at Seldovia on the 13th. The little flat-bottomed steamer *Tyonic* was in waiting and left the same night for the ports in the north of the inlet, and arrived at Kenai the next morning.

I found Mr. Nielsen and Mr. Ross engaged in breaking new ground. (Pl. X, fig. 1.) There are now at the station 21 acres cleared, broken, and fenced. The first 5 acres were cleared immediately back of the village, but it was found that the winds from the sea, which swept in unobstructed, damaged the crops. The next 16 acres were therefore cleared some little distance back in the woods so as to leave a shelter belt of timber to protect the crops from the sea winds. This has been found to be an advantage, but it is believed that still better protection will be afforded farther back, and the next field to be cleared has been chosen with this end in view.

In the middle of August, when the writer was there, the crops looked well and gave promise of a plentiful harvest. (Pl. XI.) But the promise was not fulfilled. It will be seen from Mr. Nielsen's report, submitted herewith, that none of the grain matured this year. Heretofore the earlier varieties of grain have matured, but this year was an exception in this respect. The spring was late and the summer averaged colder than in previous years. There was less sunshine than usual, with a great deal of misty, overcast weather. The number of clear days was as follows, by months: May, 9; June, 6; July, 12; August, 10. But whatever the cause, the fact remains that grain failed to mature. Of the five years during which we have been at work on this station this is the only total failure to mature grain. From the data now at hand it is evident that grain growing for the seed is uncertain along the coast on the Kenai Peninsula. But there is reason to believe that grain can be matured some 10 or more miles from the coast where the influence of the winds and mists from the inlet are less sinister.

STOCK RAISING A SUCCESS.

But there is no doubt in regard to stock raising. The station work oxen have now been kept for five years, winter and summer, wholly on native-grown feed—grass in summer and hay or silage in winter—and they have been kept in sufficiently good condition for work. We have also made a start in keeping cows.

Cattle have been kept at Kenai and Ninilehick for many years. The native stock is a diminutive Siberian breed, but at Kenai they have been improved by the introduction of American cattle, and the two cows owned by the station at this writing are of average size. That live stock can be grown there has been proved, and I therefore recommend that hereafter special attention be given to animal industry at this station. If the money is available I recommend the building up of a small dairy herd and that a dairy equipment be provided. This, however, should not be done if it will in any way retard the development of the stations in the Copper River Valley and at Rampart on the Yukon, for I consider that these stations are of more immediate importance than the Kenai Station. But provided that these stations do not suffer, the work of clearing and improving land at Kenai should continue, and a small herd of general-purpose cattle should be collected there with a view to inaugurate dairy work when the necessary equipment can be provided. Nowhere in Alaska has butter or cheese been manufactured, and it will be an instructive and profitable experiment to ascertain what cattle raised on native feed can produce in this line.

A CHANGE IN SUPERINTENDENT.

Mr. H. P. Nielsen, who has been superintendent of this station since the breaking of the first sod in the spring of 1899, has resigned, and Mr. P. H. Ross, a graduate of the Kansas State Agricultural College, has taken his place. Mr. Nielsen has been an energetic and industrious worker, and most of the hard work of clearing the land has been done by him. He has erected all of the buildings and laid the foundations of the station, from which much usefulness in the future may be expected. Mr. Nielsen's report follows herewith:

REPORT OF H. P. NIELSEN, SUPERINTENDENT OF KENAI STATION.

KENAI, ALASKA, *October 14, 1903.*

DEAR SIR: I herewith submit report on work for the season of 1903.

CLEARING OF NEW LAND.

In addition to work with experimental crops on the 15 acres previously cleared and broken we have cleared of trees, stumps, and brush,

and broken 6 acres more and fenced it. For convenience the field by the house is designated in this report as Field A; the field back in the woods, Field B.

GENERAL IMPROVEMENTS AND ADDITIONS.

Last year I purchased a building of the Alaska Packers Association which had been used for quarters for Chinamen while the cannery here was in operation. The object was to tear the house down and with the lumber build a barn for implements and grain. The building as it stood measured 75 by 24 by 10 feet. I took it down, moved the lumber 2 miles, and built a barn here measuring 64 by 24 by 10 feet; we having some lumber left. The old implement shed is being converted into a stable for horses and cattle. (Pl. XII, figs. 1 and 2.)

Fourteen hens and a cock were bought in August and the old silo building converted into a chicken house.

A 3-year-old cow was bought in August for the station.

One of the oxen brought up here in 1899 died last spring.

Last year a yoke of oxen were shipped here from Portland, Oreg., but one of them had received so severe injuries on the voyage that he died a week after landing.

The station herd now consists of 2 cows, a 16-month-old heifer calf, a 2-year-old steer, and 2 oxen; 6 head in all.

Twelve tons of native grass were cut, cured, and stacked in July and August. About 7 tons of this are now in stack.

Of the orchard set out in the spring of 1902 there are alive 3 apple trees, 1 cherry tree, 7 raspberry bushes, 10 gooseberry bushes, and 1 currant bush.

The apple trees grew very slowly during the summer. The cherry tree grew shoots about 3 feet long, and seems healthy. The raspberries made a remarkable growth from the roots and sent up many new canes, but all of last year's stems were winterkilled, so they did not bear any fruit. The gooseberries grew new stems, 2 to 3 feet long, but did not bear. The currant bush made a normal growth without bearing any fruit. The strawberries, 3 varieties, did remarkably well, and ripened nearly a gallon of berries, but, owing to the birds, there were seldom more than 3 or 4 ripe berries to be found at a time. New plants were made by the hundred in the latter part of the summer, so the beds will need to be extended next year.

The grain has been hauled off the field, and the portion which was dry enough to stack has been stacked up; the rest is standing in shock in the stack yard. Five acres of the grain field have not yet been plowed this fall.

NOTES ON VEGETABLES.

Potatoes.—Early Rose and Early Burbank were planted May 23. They did not all come up until about July 6, but when once up they

grew rapidly. The yield was not so good as last year, but two-thirds of the Early Rose and one-half of the Burbank were marketable. They were dug September 24.

Success with vegetables this year was not so good as usual, except with cabbage, celery, and parsley. The peas did fairly well, but were late in coming into bearing. The lack of success with the other things was due partly to the cold summer, but mostly to the fact that the soil was new. It was given a liberal dressing of manure last spring, but it did not have time to decay sufficiently to help the plants much this year.

April 27 I planted in the cold frame the following seeds: Cabbage, Jersey Wakefield; cauliflower, Early Snowball and Dwarf Erfurt; lettuce, Big Boston and Morse; kohlrabi, Large White; broccoli, Mammoth White; cucumber, White Spine; celery, Improved White Plume; onions, Yellow Globe Danvers; parsley, Plain Single; and Brussels sprouts.

The cabbage was set out in the open June 3 and did very well. Less than 1 per cent of the plants set out failed to grow and most of those that grew made good-sized heads. The cabbage last summer was the best I ever raised.

The cauliflower and broccoli plants were set out June 8, but did not amount to anything. The plants kept green all summer, but they did not begin to grow well until in August, and the frost killed them before they came to head.

The kohlrabi plants were set out June 3 and did fairly well.

A few plants of both varieties of lettuce were set out June 8, but they did not develop to large heads.

The cucumbers did not get large enough to transplant. I do not think cucumbers can be raised here. I have tried them five years now without success.

I had no ground prepared rich enough in which to transplant celery. I therefore took out the other plants and transplanted the celery to the cold frame, and it grew magnificently. Of course, I did not have room to bank it up, but some of the plants grew 15 inches high, and as they stood so closely they partly bleached without banking. It is finely flavored and tender.

The onions were left in the cold frame and the largest bulbs attained a size of 1 inch in diameter.

The parsley was also left in the cold frame and grew to be 1 foot high.

On May 19 I planted the following varieties of peas: American Wonder, Hosford Market Garden, Earliest of All or Alaska, and Thorburn Extra Early Market. There was no noticeable difference as to earliness, for they were all late. They were not eatable until about the 1st of September. Hosford Market Garden grew the largest vine, it being about 3 feet tall.

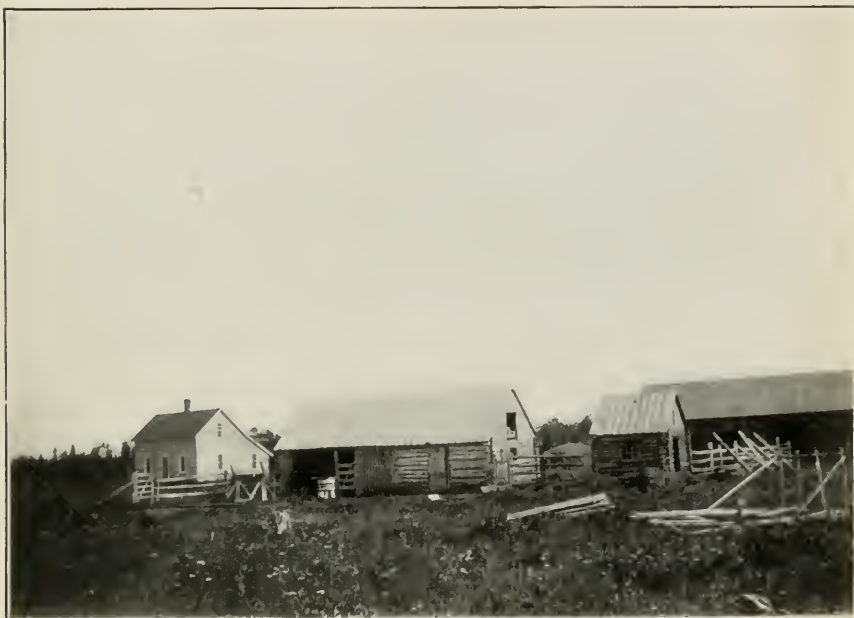


FIG. 1.—ALASKA STATIONS—STATION BUILDINGS AT KENAI STATION.



FIG. 2.—ALASKA STATIONS—NEW BARN AT KENAI STATION.

On May 20 I planted beets, Early Egyptian; carrots, Early Scarlet Horn; parsnips, Hollow Crown; corn salad; and ruta-baga, Large White.

The beet, carrot, and parsnip seed were soaked in water over night, but they did not come up until about five weeks after planting. The beets amounted to nothing. The carrots were small, largest roots being only 1 inch in diameter and 2 and $2\frac{1}{2}$ inches long. The parsnips did not do so well. The corn salad came up in about three weeks, but grew very slowly. It is green at the present time, but only 2 inches high, and has not been picked. The ruta-bagas came up in about two weeks, but did not get very large; a few of the largest weighed 1 pound a piece. They needed richer ground.

On May 28 I planted mustard, White London; garden cress; spinach, Savoy; kale, Siberian; and radishes, Early Scarlet and French Breakfast. The mustard did not get large, neither did the cress. The spinach went to seed without making many leaves. The kale grew well; some of the leaves were 14 inches long, and the plants stood quite thick in the rows. The radishes did fairly well, but were a long time attaining an eatable size.

Turnip (White Dutch) was sowed broadcast June 10, and the seed covered by raking the ground over with the garden rake. They did fairly well, but none of them became exceptionally large.

FIELD CROPS.

Winter grain.—Giant Winter Rye seeded August 25, 1902. September 3 there was a fine stand 3 inches high. October 1 it was 6 inches high and spreading out. It wintered over in good shape, and on July 1, 1903, there was a good stand, 3 feet high, fully headed. July 15 it was $5\frac{1}{2}$ feet high. August 1, 6 feet high and just going out of bloom. August 19, 6 to 7 feet high, filling out nicely and promised well. September 1, ripening and grain in the dough. September 15, grain injured by the frost. The chaff and straw were ripe, but the seed would not harden. It was cut September 21. The grain is not mature enough to make seed.

Excelsior winter rye, seeded at the same time and in the same kind of ground as the above variety. Growth and results the same as the above.

Two other varieties of rye (Schlansted and Fechtin) were sown, but the seed failed to grow.

A plat each of Excelsior winter wheat and Giant winter rye was sown August 18 last. At the present time the plats are green and look very promising.

SPRING CROPS.

Wheat—Romanow.—Two plats were seeded, one in Field A, May 26, and one in Field B, June 4. On June 6 the plat seeded May 26 was coming up. The plat seeded June 4 was coming up June 14. On July 1 it was noted in Field A, stand excellent, 4 inches high. In Field B, stand excellent, 5 to 6 inches high. July 15, in Field A, growth spindling, 6 to 8 inches high; in Field B, 8 inches high. August 1, in Field A, 1 foot high; in Field B, 18 inches high. August 19, in Field A, 24 to 30 inches high and beginning to bloom; in Field B, 36 inches high and in bloom. September 1, in Field A, 30 to 36 inches high, in bloom; in Field B, 4½ feet high, in bloom. September 15, in Field A, 42 to 48 inches high, still in bloom. It will make no grain. In Field B, 5 to 6 feet high and still blooming. Both plats were cut September 22, the straw to be used for hay.

Barley—Manshury, seeded May 28. June 6, was just showing above ground. July 1, stand excellent, 3 to 4 inches high. July 15, 4 to 6 inches high. August 1, 12 to 20 inches high and beginning to head. August 19, 30 to 40 inches high and in bloom. September 1, passing from milk to dough, 3 to 4 feet high. September 15, about 30 per cent still in the milk; rest in the dough; straw still green. When cut, September 29, a small percentage of the straw turning yellow, mostly green. Grain spoiled by the heavy frosts of September 23, 24, 26, 27, and 28. No seed ripe.

Oats—Sixty Day.—Two plats of this oats were sown, one in Field A, May 26, which was just coming up June 6. The other plat was sown in Field B June 4. July 1 the stand was good, 3 inches high in both fields. July 15, in Field A, 6 inches high; in Field B, 7 inches high. August 1, in Field A, 12 inches high, 10 per cent beaded; in Field B, 14 inches high, but no heads yet. August 19, in Field A, 30 inches high and in bloom; in Field B, 36 inches high and in bloom. September 1, in Field A, some in bloom, some just past; in Field B, 4 feet high and in bloom. September 15, in Field A, 36 to 42 inches high, grain in milk and dough, a few hulls turning yellow, straw green yet, beginning to lodge badly; in Field B, 4 feet high, badly lodged, grain in the milk, straw green. The plat in Field B was cut for hay September 23, no grain ripe. The plat in Field A was cut September 28, no grain ripe.

Swedish Select.—Two plats were seeded with this variety, one in Field A, May 26, and one in Field B, June 4. The plat seeded May 26 was just showing above ground June 6. The plat seeded June 4 was coming up June 12. July 1, in Field A, stand good, 3 inches high; in Field B, stand excellent, 3 inches high. July 15, in Field A, 4 to 6 inches high; in Field B, 8 inches high. August 1, in Field A, 12 to 14 inches high; in Field B, 20 inches high. August 19, in Field

A, 30 inches high, in bloom; in Field B, 36 inches high, just headed out. September 1, in Field A, just past bloom, 3 feet high; in Field B, 5 feet high, in bloom. September 15, in Field A, 42 to 48 inches high, some spots 5 feet high, grain in the milk and still growing, color dark green; in Field B, what is standing is 5 to 6 feet high, 75 per cent of it flat on the ground from the recent storm, grain in the milk, color dark green. Both plats were cut September 23. As there was no ripe grain it will be used for hay.

Common field oats seeded June 15. July 1 there was an excellent stand, 2 inches high. July 15 it was 3 inches high. August 1, 8 inches high. August 19, average height 16 inches, beginning to head. September 1, 30 inches high, about 90 per cent headed. September 15, 36 to 42 inches high, fully headed, about 20 per cent in bloom. It was cut for hay September 26 and 27. No grain whatever in the heads.

Two acres was sown to Burt Extra Early oats with seed raised here in 1902, but it failed to make a stand.

Buckwheat.—Orenburg, seeded May 26. July 1, stand excellent, 1 to 2 inches high. July 14, 2 to 4 inches high, beginning to bloom. August 1, 8 to 12 inches high, in full bloom. August 19, 12 to 18 inches high, in full bloom, some seed formed. September 1, killed by frost, no seed ripe. It was cut September 10.

GRASSES.

On July 1 notes were taken. Grasses seeded in the spring of 1902, as follows:

Dactylis glomerata.—Leaves 6 inches in height, a few seed stalks headed out, 20 to 24 inches high.

Agrostis vulgaris.—1 foot high, heading out.

Lolium perenne.—Winterkilled.

Bromus inermis.—16 inches high, fine stand.

Poa pratensis.—1 foot high, heading out.

Festuca elatior.—Growth spotted, 6 to 20 inches high, no heads yet.

Avena elatior.—Winterkilled.

Phleum pratense.—12 to 16 inches high, just showing a few heads.

Alopecurus pratensis.—30 inches high, fully headed, and in bloom.

These plats were all mowed for hay July 6. A second crop of hay was mowed September 10. Yield somewhat smaller.

On June 1 and June 2, 1903, a small plat each of the following grasses and forage plants were seeded: *Bromus inermis*, *Dactylis glomerata*, *Lathyrus sylvestris*, *Aira caespitosa*, *Polygonum sachalinense*, *Ulex europaeus*, *Avena elatior*, *Alopecurus pratensis*, white clover, red clover, alsike clover, *Phleum pratense*, *Lolium perenne*, *Festuca elatior*, *Poa pratensis*, and *Poa aquatica*.

Of these varieties, *Aira caespitosa*, *Polygonum sachalinense*, and *Poa aquatica* failed to grow.

Bromus inermis.—July 1, stand was good; 1 to 3 inches high. July 15, 3 to 4 inches high. August 1, 4 to 5 inches high. August 19, 6 to 8 inches high. September 15, 12 to 15 inches high. This plat has been pastured, but is still green.

Dactylis glomerata.—July 1, just up. July 15, stand good, 1½ to 2 inches high. August 1, 5 inches high. August 19, 6 to 8 inches high. September 1, 8 to 12 inches high. Pastured the last week. Growth has ceased, but plat still green.

Lathyrus sylvestris.—September 1, just coming up. September 15, stand good, 2 inches high. October 10, 3 inches high; plants green, but growth stopped.

Ulex europaeus.—July 15, stand uncertain, just showing above ground. August 1, just coming up. August 19, stand good, 2 inches high. September 1, 4 to 5 inches high. No progress.

Avena elatior.—July 1, stand fine, 1½ inches high. July 15, 2 to 4 inches high. August 1, 8 to 10 inches high. August 19, average height 16 inches; beginning to head. September 1, 18 inches high; fully headed. It was about 2 feet high on September 15, when it was mowed for hay. The stubble started growing at once. Plat still green.

Alopecurus pratensis.—July 1, stand uncertain, just coming up. July 15, stand good, 1 inch high. August 1, 2 to 3 inches high. August 19, 4 inches high. September 1, 5 to 6 inches high. September 15, a few seed stalks 24 inches high; body of grass 6 to 8 inches high. Plat still green.

White clover.—July 1, just coming up. July 15, stand good, ½ inch high. August 1, 1 inch high. August 19, 3 to 5 inches high. September 1, 4 to 6 inches high. September 15, 6 to 8 inches high. September 17, cut, and with the other 2 varieties of clover used for silage.

Red clover.—July 1, fine stand, 1 inch high. July 15, 1½ to 2 inches high. August 19, 4 to 6 inches high. September 1, 6 to 8 inches high. September 15, 8 to 10 inches high. Cut for silage September 17.

Alsike clover.—July 1, just coming up. July 15, stand good, ½ inch high. August 1, 1 to 2 inches high. August 19, 4 to 6 inches high. September 1, 6 to 8 inches high. September 15, 8 to 10 inches high. Cut for silage September 17.

Phleum pratense.—July 1, just coming up. July 15, stand good, 1 inch high. August 1, 2 to 3 inches high. August 19, average height, 6 inches. September 1, 8 inches; beginning to head. September 15, growth spotted, 10 to 18 inches high; fully headed; earliest heads in bloom.

Lolium perenne.—July 1, good stand, 2 inches high. July 15, 3 inches high. August 1, 4 to 5 inches high. August 19, 5 to 6

inches high. September 1, 8 to 10 inches high; spreading out. September 15, same as before. October 10, plat still green, although the cattle have pastured it close.

Festuca daltior.—July 1, just coming up. July 15, 1 to 1½ inches high. August 1, 2 inches high. August 19, 4 inches high. September 1, 6 inches high. September 15, 6 inches high.

Agrostis vulgaris.—July 15, good stand, 1 inch high. August 1, 2 inches high. August 19, 6 inches high. September 1, 8 to 10 inches high. September 15, 10 to 12 inches high. The cattle have eaten this plat off quite close.

Poa pratensis.—July 15, stand uncertain; just coming up. August 1, 1 inch high; stand uncertain. August 15, uncertain. September 1, smothered by weeds.

Rape.—Seeded June 1. July 1, just up; stand good. July 15, 2 to 4 inches high. August 1, 6 to 10 inches high. August 19, 12 to 18 inches high. September 1, 18 inches high; flower stalks appearing. September 15, just beginning to bloom. Cut for hay about 2 feet high.

Hemp.—Seeded June 1. July 1, just up; stand uncertain; 1 inch high. July 15, stand uncertain, 2 inches high. August 1, 3 to 6 inches high. August 19, 6 to 12 inches high. September 1, 1 to 2 feet high; no blossoms yet; will not make anything. September 15, 1 to 3 feet high; making buds; no blossoms yet. Cut down September 21. A total failure.

Respectfully submitted.

H. P. NIELSEN, *Superintendent*.

Prof. C. C. GEORGESON,

Special Agent in Charge of Alaska Investigations,
Sitka, Alaska.

RAMPART STATION.

The following grains matured at Rampart again this year. Named in order of their appearance in Plate X, fig. 2, from left to right, they are as follows: Flying Scotchman oats, Mansbury barley, Black Finnish oats, Burt Extra Early oats, Romanow spring wheat, and common oats. The Black Finnish oats is a very fine sample. It stands 5 feet high and has a good grain. The Mansbury barley is also good. The others are inferior.

As stated elsewhere, the patch of cleared ground has been cultivated by Mr. J. W. Duncan under the direction of the special agent.

I recommend most earnestly that a regular employee be put in charge of the station, and that a team of horses and the necessary farm implements be provided. This should be done as early in the coming season as possible, in order that ground may be prepared for the year following. The equipment and the first year's work will cost \$5,000, the cost of transportation and freight being perhaps the heaviest items.

REPORT OF REV. C. P. COE ON COOPERATIVE EXPERIMENTS AT
WOOD ISLAND.WOOD ISLAND, KADIAK, ALASKA, *September 11, 1903.*

DEAR SIR: I have the honor to submit herewith the report of the agricultural work and experiments for this present year. Owing to your request to have the report early, I am unable to give final and definite results in many cases. The weather has been so unfavorable throughout the season that the results are far from being as favorable as usual. On two days only has the thermometer reached 80° F.

All the land used was treated to a light dressing of fish guano, and all the stable manure obtainable was also used. Some of the most thoroughly decayed vegetation from a marsh was used as a fertilizer on three plats, but without any definite results. It would supply humus, but is very slow in decaying.

FIELD CROPS.

Barley.—Beardless.—Seattle seed sown on sandy land April 23, as nurse crop for grasses, vetches, etc., made a slight stand, and has grown to about 18 inches in height. Heads are short, but large in diameter, and seed is large and heavy. It will mature.

Manshury.—Minnesota seed, sown on May 5, on land used one year before, has made a growth of 2½ feet, good straw, moderate, well-filled heads, and will mature.

Manshury.—Home-grown seed, sown on new ground May 11, made good growth of straw and some heads would mature. It will be cut for feed when weather permits.

Buckwheat.—Japanese.—Seattle seed. Sown on three plats May 22, 23, and 26. Land was all old; conditions favorable. All plats blossomed, and a few seeds are to be found now, but none would mature.

Corn wheat.—Two plats were sown May 13 in drills, and May 22 broadcast, on old land. The first plat grew straw 4 feet high, and from a distance seemed to have fine heads, but they were all empty. It was cut for hay September 8. The other plat was destroyed by geese.

Flax.—Seed from Seattle. Sown May 13, 22, 23, 26, and June 2. Three of these plats have done very nicely and will furnish seed. The stalks are about 16 inches high, and the seed pods are now well filled and the seeds getting hard. The other two plats did no good. This is the first time flax has done so well.

Kale.—Thousand Headed.—Sown in wet places, broadcast, and has failed to do any good. Few seeds germinated, and those that did have furnished plants but about 8 inches high now. Last year the success was much better.

Millet.—Hungarian.—Sown May 22, 26, and June 2, and has done no good. A few spears may be found 4 or 5 inches high.

Oats.—Several experiments were made with oats. The results were fairly favorable. Oats will be counted one of the most satisfactory crops.

Black Finnish, home-grown seed, sown May 11 on land broken last fall, made a good growth and will be cut for hay.

Swedish Select, Dakota seed, sown May 5 on old land, now stand $2\frac{1}{2}$ feet high, are well headed, and will mature. On new land they were sown May 11 and will be cut for feed.

Thousand to One, home-grown seed, sown May 11, made good growth and will be cut for hay.

Right Side, home-grown seed, sown May 6, stand $3\frac{1}{2}$ feet high, are well headed, and will mature. Sown on new land May 11, the result was the same as other varieties.

Seattle seed oats on new land gave same results.

Sixty Day, Sitka seed, sown May 5, are $2\frac{1}{2}$ feet high, but badly lodged by storms the early part of September. They are well headed and will mature, if not beaten down again by the winds.

Mixed White, home grown, and will also mature. They now stand $3\frac{1}{2}$ feet.

Peas.—White Canadian and Blue Prussian peas were sown with oats for feed. The result was favorable, but the yield was not large, probably 8 tons green feed to the acre. On sandy land they did no good.

Rye.—Experiments with rye were confined to three sowings of Excelsior, three of Giant, and one of Schlonsted seed. Most of these were made in August last year, and two as late as October 3. The straw of the rye was about 5 feet high, but the heads were empty. It was cut for hay in September.

Rape.—Dwarf Essex and Dwarf Victoria were sown in oats May 5. At this writing it is not more than 4 inches high, even where the oats failed. Last year the rape put into the silo rotted.

Spelt.—Home-grown seed was sown May 6. It is 3 feet high and will probably mature.

Vetches.—Both Spring and Sand vetches were sown in barley on sandy land April 23. Some plants have made a growth of 2 feet from the crown, but the stand is poor and will not mature seed.

Wheat.—Experiments were made with Romanow from imported Russian, Sitka, and home-grown seed, all on similar soil. The plats were sown May 5 and 6. The Russian seed made a good stand, and the grain stands about $2\frac{1}{2}$ feet high. The heads are medium length and small; seed may mature. The Sitka seed did better. The grain is 3 feet high, the heads longer and larger, and seed will probably mature. The home-grown seed has made about the same showing as

the Sitka seed. Seed from Seattle on new land grew 3 feet high, and will be cut for hay.

Marvel Spring wheat.—Home-grown seed made a growth of about 3 feet, and has been cut for hay.

GRASSES.

Bromus inermis.—Sown with barley on a sandy field, but has not made any showing. Where sown previously it does not now show.

The grass plats sown last year survived the winter and were cut for hay the first of September. The half acre made about half a ton of hay.

Johnson grass was sown under same conditions as the clover, and a few roots can be found. These are bearing seed.

Timothy.—A plat of timothy sown two years ago is as fine a piece of grass as one could ask to see anywhere. It stands 3 feet high and has long full heads at present. We are saving it for seed. The stalks are well leaved, and the yield would be very satisfactory. Timothy has been used to sow on meadows and pasture lands, and the results have been satisfactory.

CLOVER.

Alfalfa was sown with barley as a nurse crop and made a small stand. Some stalks are 10 inches high. This was on sandy land. The stand is probably not sufficient to justify saving.

Alsike clover has not done well. Neither that sown on sandy land this year nor that sown last year.

Esparsette was sown with barley on sandy soil, but not a stalk can be found.

Crimson clover was sown with barley; nothing to be seen.

Mammoth red clover, under same conditions as alfalfa, has made about the same record.

White clover was sown with timothy on meadow and is showing well.

Wild rice has been sown in the lakes. That sown in the spring has not made any showing, and that sown this fall has not had time to do so.

VEGETABLES.

It is in this part of the work that failure has been met with in greatest measure, and that too with vegetables that have given the best results in previous years. Cabbage, cauliflower, celery, celeriac, and broccoli in several varieties were sown in window boxes and hotbeds as early as March 9 and in the open May 1. Plants were transplanted into cans, and from the cans into the garden May 23, but it is doubtful if we will have one head of cabbage, or more than half dozen heads of cauliflower. Celery, celeriac, and broccoli are no better.

Caraway seed was sown, but has made no showing.

Carrot.—Short Horn germinated poorly, but grew to fair size and were very fine. Half Long Danvers and White Belgian have done nothing; on old land, too.

Chervil planted May 1 and 22 did nothing. Corn salad ditto.

Cress, curled, sown May 1, germinated slowly; seeded quickly.

Water cress was sown along margin of streams, but has not grown well.

Beets.—Early Egyptian, sown May 1, has done as well as beets can be expected to do, better than ever before here. Long Smooth Blood beet, Half Long Blood, Golden Tankard mangle-wurzel, and Mammoth Long Red mangle-wurzel germinated very poorly and have made very little growth.

Dill was sown, but no seed germinated as far as can be seen.

Endive was sown May 1, and but few seeds germinated. Plants that grew went to seed speedily. Another plat sown June 2 is now ready for use. In this seed germinated well.

Beans.—Red Valentine and Six Weeks varieties have grown to about 4 inches in height and have blossomed.

Kale was sown in the open May 1, and at present is ready for use.

Kohl-rabi was sown in open May 1; a few seeds germinated, but are no account.

Lettuce.—Many varieties of lettuce were sown, such as Boston Market, San Francisco Market, Hanson, Deacon, Prize Head, etc. Of these San Francisco Market has proved the only good variety this season. Others did well for a little time, but soon went to seed. The San Francisco Market was sown May 1, and from the time it became ready for use until the present has been improving. From that one seeding we have had lettuce all the summer for our use and for sale, and now there are heads as large as early cabbage, solid and crisp. Few heads have sent up seed stalks.

Leek.—Carenton were sown in hotbed May 10, and set in open May 23, sown in open May 1. Results nothing.

Onions.—Onion sets were planted May 23, but did not do well. We have at no time succeeded in raising onions of any considerable size. May 1, Australian Brown, Prize Taker, and Pink Prize Taker onion seed was sown in the open on old garden plat and at this time we have good bunch onions that are very fine, but they are not more than three-fourths of an inch in diameter. The Prize Taker have given better results than the Australian.

Parsley.—Triple curled was sown in hotbed and May 1 in the open garden. Few seeds germinated. That in the open which did germinate have produced very fine plants.

Peas.—Peas have been next to a failure. A very few times we have been able to gather a sufficient quantity to serve at the table, although

there were a great many planted. The varieties sown were Alaska, First and Best, Scorchers, and Horsford.

Potatoes.—Potatoes were planted April 28, May 6, 16, 22, and 26, using old land in all cases. One patch planted May 22 has failed entirely, but the others have done fairly well. In each of the best two fields I dug 1 rod September 9, and the yield was 18 pounds. This, at 800 rods of potato rows to the acre, gives a yield of 240 bushels. The tubers should grow considerably still this fall, as the vines at this time are still in bloom and vigorous. Potatoes on sandy land will yield a little more than half as well as those above noted.

Radishes.—Radishes were planted in large quantities and at various times with good results. Early Scarlet, Long Scarlet, Early Bird, French Forcing, all did as well as could be expected at every planting, but the radishes soon became hollow. Black Spanish germinated well, but ran to seed before making roots of desirable size. Scarlet China Winter radishes were sown in August and are looking well now, but will need several weeks of growing weather to make satisfactory roots.

Ruta-bagas.—Ruta-bagas of two varieties were planted, one plat of each April 28 on sandy land, similar to that on which they made a good yield last year. The roots are small at this writing and the yield will be light, although the seed germinated well. May 26 another plat of each was sown. The land is better, and the roots will be larger, but not so large as last year on the same ground. The kinds planted were Yellow Swede and Sweet Russian.

Salsify.—Long White has succeeded for the first time in our experience. The tops have grown to 18 inches high, but the roots are small, about three-fourths of an inch in diameter.

Turnips.—Amber Globe, White Milan, and Yellow Aberdeen were sown May 25 and 26. The roots will be small and the yield very light on the ground that gave such excellent results last year. In an old garden which is very rich we had a few turnips which measured 8 inches in diameter. The crop is practically a failure.

FLOWERS AND TREES.

With flowers, such as poppies, nasturtiums, corn flower, sweet peas, and pansies we have had success, as usual. Several hardy bulbs secured a year ago last spring failed to survive the winter. Shrubs have failed to do any good, but I still believe both bulbs and shrubs could be grown. Small fruits have been given little attention, but hardy varieties should do well. One crab-apple tree has survived and has made a little growth in three summers. Some black locust seed was sown in the spring and a few seed germinated and have produced plants 2 inches high.

LIVE STOCK.

The winter was severe on stock that was not fed and, as few people were prepared to feed throughout the winter, many cattle died and many calves could not be raised.

At the orphanage, counting our own and orphanage cattle, the loss of cows and calves was 10 head altogether. Some of these losses might be attributed to the severe winter, others were occasioned by falling from cliffs, 1 by drowning, 1 from injury, and for 1 the cause is unknown.

However, the cattle have done well this summer, and from a herd of 5 milch cows, 3 of which are giving milk for the first time, the following record was made, in August, which is about the same as the other months since the first of June:

Milk record of 5 cows for month of August, 1903.

	<i>Pounds.</i>		<i>Pounds.</i>		<i>Pounds.</i>
August 1	85.5	August 12	93	August 23	87.5
August 2	85.5	August 13	71.5	August 24	83.5
August 3	87	August 14	76	August 25	85
August 4	91	August 15	87	August 26	86
August 5	85.5	August 16	88.5	August 27	90
August 6	83	August 17	83	August 28	85.5
August 7	86	August 18	82	August 29	83.5
August 8	79.5	August 19	81.5	August 30	83.5
August 9	95.5	August 20	83	August 31	85
August 10	97.5	August 21	85		
August 11	85	August 22	85.5	Total	2,649.5

This record was made with no feed except pasturage in woods. The calves were not allowed to suck the cows, but were fed on fresh milk for several weeks, then on skimmed milk until they ate grass freely, since which time they have had nothing but grass, and they are vigorous and doing well. From the milk we have had all we wanted for our large family and have made an average of 12 pounds of butter a week since the middle of June.

Since the spring work was completed the horses have been allowed to run loose. They have become very fat with no feed except grass.

The Angora goats wintered with but little feed and attention. They ate the silage readily and browsed from the spruce trees. They were sheared April 21 and yielded 22 pounds of good quality of mohair—4 pounds for each doe and 6 pounds for the buck. Samples were sent to a dealer in mohair, and 30 cents per pound was offered for the same. This spring the buck died, owing to his eating a large quantity of ground feed. There has been no increase in the flock.

Poultry has ever been one of the most profitable departments of our work. The past year has been no exception, although we have met with some serious reverses.

An incubator was added last spring and was run successfully in hatching both chickens and ducks which were intrusted to homemade brooders, patterned after plans given in what was supposed to be a reliable authority. At the age of about a week the chicks began to die, and but few were saved from the first hatch. Afterwards the chicks were given to hens and they thrived better. We have at this time about 70 young chickens and 40 young ducks. The yield of eggs may be interesting, and is given by months for each variety.

Egg-laying record of hens and ducks.

	March.	April.	May.	June.	July.	August.	Total.
B. Langshans, 24 hens.....	240	339	438	285	250	420	1,972
W. Wyandotte, 2 hens.....	12	33	25	14	11	20	98
Pekin ducks, 3 hens.....	12	87	77	50	.....	.....	226
Common ducks, 6 hens.....	.....	103	121	90	.....	.....	314
Total .....	.....	.....	.....	.....	.....	.....	2,610

The Pekin ducks mature much more quickly than the common kind, do not sit, are not rangers, and need water only for drinking.

The Wyandotte chicks seem less hardy than the Langshan, and we have succeeded in raising few of them. A small flock of geese has been added to the list of poultry. Others have succeeded very well with them here and at Kadiak.

CURTIS P. COE,

Superintendent Kadiak Baptist Orphanage.

I beg leave to call special attention to the following letter from Mr. W. H. Swinehart, at Fort Selkirk, Yukon Territory:

DEAR SIR: Yours dated May 14, 1903, just at hand, and in reply will make an effort to describe in a meager way the methods we pursue after five years' experience at agricultural work on the Yukon.

To begin with, we are the pioneer farmers of this country beyond a doubt, as we were plowing on June 21, 1898, at this place, our present field of operations. Further, we do not wish to be classed with the truck gardener of this section, as we adhere strictly to field farming without irrigation, nor do we use hothouses or hotbeds of any description—just straight farming, pure and simple. In the East many believe that we must use canvas or other means to start plants, and then transplant to the field or garden. This is erroneous. We sow seeds in drills after the soil becomes fit to receive them. First our home garden, usually from May 1 to May 10 (as early as possible of course); after that we drill according to the vegetables and the time it takes to mature them.

We grow winter-keeping goods altogether, as we have no truck market at this point. Last season we seeded for winter goods the following dates: Carrots and beets, May 10; potatoes, May 14; ruta-bagas, June 3; parsnips, June 4; cabbages, May 7. We considered it too early for the ruta-bagas, as they grew too large for nice marketable goods, and this year we will not seed for ruta-bagas before June 20.

Oats we sow in the usual way about May 1 and harvest rather green for hay. Oats fully mature here—at least they have the past four seasons.

What experiments we have made with grasses have been with timothy and *Bromus inermis*. The latter does best on dry lands. We have sown timothy seed with oats, on May 1, and harvested August 5 as good a crop as can be raised in almost any country, the timothy standing from 24 to 39 inches in height, with longer and heavier heads than the average crop growth in the States. We have never seen such a growth from timothy seed in any other place, and we know that it will sound like a fairy tale to many, if not all, eastern farmers. But when one takes into consideration the twenty-hour sunlight in every twenty-four hours of the day—June has twenty-one hours' sun every day from the 15th to the 25th—and compares the sunlight the farmers in the East get, one can readily see almost a double growth in the same growing months. We have grown 10 tons of oat hay from 3 acres of land. We have only 18 acres under plow, and about half of this we seed to oats for hay, the balance to winter-keeping vegetables. We have also large native hay marshes, but the demand for native hay is almost a thing of the past. The growth of native grasses is something marvelous, and we use it on the ranch extensively.

Last year we harvested 11 tons of fine Early Rose potatoes from 2 acres of land, digging them September 10 to 15.

Our most troublesome plant has been the cabbage. We found that early planting gave the poorest results, and from experiments along the line deduce the following: The cabbage plant grows so fast during May and June that the leaves become so large and heavy that when the folding season begins they are too overgrown to lift and fold without assistance, consequently can not make solid heads. As a result from experimenting with this plant, we drill the seed like other vegetables in the field—this year May 16. Last season we had all our box cabbage plants that had been transplanted to the field killed by a frost on June 9. They were of a good size, about 3 inches high, and were frozen into the ground. Alongside was cabbage from seed sown a month later, in the field, none of which were touched by the frost. Acclimated during growth, they made fine heads, some of them bursting they were so solid. The house-raised plants were a failure. From this experience we have abandoned all transplanting, confining our efforts to the method outlined.

Small garden truck, such as lettuce, radishes, peas, and onions from seeds grow readily with little care and attain a larger size in the same growing time than we have ever seen elsewhere. We have grown ruta-bagas that weighed 20 pounds, turnips 15 pounds, winter radishes 6 pounds, and potatoes $1\frac{1}{2}$ pounds each, all within 90 days of drilling the seed. Beets and carrots do the very best with us, and are among the best sellers on the market. We attribute this wonderful growth to the extra sunlight. We do not claim that all the valleys in the Yukon Territory will give the results we have mentioned above, for our observations in moving about the Territory have been that three-fourths of the soil in the Yukon Valley carries too much gravel to grow anything in the form of roots, as there is no subsoil to retain moisture. Then, again, much of the soil in this section of the Territory is too wet and cold. Further, the late July and August frosts along the Yukon River and its tributaries are much heavier and much earlier than at some distance back. For example, at Fort Selkirk, only 2 miles distant from our ranch, they had heavy frosts two weeks earlier than we had in August, 1902. Our first frost came August 21.

We are clearing hay lands this season and seeding to timothy, which seems to be the best grass for bottom lands which are not too wet. To be inside the limit, we will say that oat hay yields $2\frac{1}{2}$ tons per acre, and nets us from 5 to 6 cents per pound; ruta-bagas, 6 tons per acre, and about 6 cents per pound or more; potatoes, 5 tons per acre, and nets 10 to 15 cents a pound, if held over for spring market. Carrots and beets, at least 3 tons per acre, and we get from 15 to 18 cents a pound for them. Cabbage varies in yield and nets 15 to 20 cents per pound, and the demand is usually

more than the supply. Having just started on timothy meadows, we are not in a position to make any positive statement as to the yield, but we think it safe to say we will get \$100 per ton for good timothy hay for some time to come.

We have a variety of wild berries near us, including the gooseberry, currant, raspberry, cranberry (both high and low bush), blueberry, and strawberry, but we have not yet given these any attention in the way of cultivation. We are trying the tame strawberry, but as we got our first plants last season can not say what can be done successfully, or otherwise, until the end of the present season.

Rhubarb is a success with us, also parsnips. Both keep through the winter months in the field same as in the East.

We are, respectfully, etc.,

W. H. SWINEHART,
Selkirk Ranch, Yukon Territory.

REPORTS FROM SEED DISTRIBUTION.

Following summaries are from a few of the reports which have been received from the seed distributed to settlers. They contain much valuable information, and intending settlers and others who desire to post themselves on Alaska can not do better than to read these letters, as they will give them an insight into the conditions in all parts of the Territory:

Rev. W. Duncan, Metlakahlla.—I am sorry to have to report unfavorably of our garden work this year. Whether our nonsuccess was due to the seeds, the excessive wet weather, or to our bad management I can not say, but we never have, that I can remember, had such poor returns for our labor at gardening.

Joseph Howard, a native of Metlakahlla.—Cabbage, spinach, turnips, carrots, radishes, peas, and lettuce were planted, seaweed and fish being used as a fertilizer with excellent results. The rhubarb has also made a good growth. We planted it in soil mixed with sand. All of the flower seeds grew nicely. We have only a little garden, but hope next year to have more room to plant all the seeds you send us.

Mr. Fred Patching, superintendent of the Naha salmon hatchery, Loring.—A start was made at this place last spring. During the month of May a few square feet of ground were cleared and planted to vegetables. Caniflower seeds were planted in the new soil without any fertilizer whatever and did very well, some of the heads weighing as much as 4 or 5 pounds, and very sweet and tender. Cabbage planted at the same time in boxes and afterwards set out did not amount to anything without fertilizer, but when I buried some fish under the plants they did very well. Radishes did fine without fertilizer, and I raised the second crop on the same ground. Lettuce was planted (the seed) without fertilizer and came up very slowly, and did not grow over one-half an inch, and died out before the end of the season. Rutabagas did fairly well without fertilizer where sown, and better where transplanted. Turnips did very well without fertilizer, and some were about 8 inches in diameter and very solid and nice. Carrots did very well without fertilizer. Onion seed was planted and used for green onions, also without fertilizer. I planted about 18 or 20 potatoes, also without fertilizer, and dug about 70 or 80 pounds. A bed about 4 feet square was made, in which some fish were buried, and planted a package of rhubarb seed and got about 35 nice healthy plants.

I have read your suggestions to pioneer farmers, and will say that this place being 8 miles from salt water seaweed is out of the question, but have lots of fish (salmon during the shipping season in the fall), and if it can be used as a fertilizer it is the easiest way of getting rid of it. This fall I spaded up the ground and buried all the fish the ground would cover, also built cribs and filled them in with layers of dirt and fish for use on new ground in the spring. In applying it last fall I had a trench

spaded out and then filled with salmon and the dirt dug from next trench, covered them, and the operation was repeated until the ground was all dressed.

R. L. Petty, Howkan.—Vegetables were raised from seeds distributed last year. The gardens were planted on Dall Island, about $3\frac{1}{2}$ miles from Howkan, in what is known as Saw Mill Cove, on the east side of the island. All ground was new, having been cleared of brush, etc., about six weeks before planting. I used seaweed, as recommended by the Department, at about 30 tons to an acre, and for new ground I consider the showing as splendid.

Garden No. 1, planted on April 25, containing 600 square feet. Lettuce was tender, extra fine quality, and lasted until October 20; Flat Dutch turnips, splendid, lasted until November 1; radishes were crisp and fine, on table twenty-four days after planting, and had them fresh and crisp until November 10; the kale this year was of the best, enjoyed by all, is still growing finely (January 3) without cover, expect plenty of early greens; Windsor beans, only fair, planted too late; parsnips and peas were in abundance and of the finest quality.

Owing to press of work in mill I did not get garden No. 2, containing 600 square feet, planted until May 5. Carrots, beets, and onions were produced; turnips were splendid and in abundance; celery, very fine, but not large—of this we had a great deal; cauliflower was set out too late, as heads did not grow large, very few being more than 4 inches in diameter, but as we had a large number of plants, size of heads did not matter. We all agree that it was as good as we ever tasted anywhere. Cabbage was put out rather too late; heads were small, but most excellent. I think cabbage needs other food in connection with seaweed. Spinach very fine and in large supply. The rhubarb sown was very fine. It was planted April 15 in large deep box, fertilized with manure from chicken house, and it grew very large and tender. We used it quite a number of times—something rather out of the common for the first year. Balance of the ground was planted to potatoes, which gave a fine crop.

John K. Smith, Howkan.—I am sorry that I am not able to make a more favorable report on the seeds sent me by the Department of Agriculture. This year I have, as most people living around here had, to be away during the fishing season, and my garden was of course neglected, but for the last eight years I have had a good garden.

I find that potatoes, cauliflower, cabbage, turnips, and celery do very well here; carrots, beets, and parsnips not so good; lettuce, radishes, and peas, excellently; black and red currants, medium crop; raspberries, medium; gooseberries, not so good, and apples so far have been a failure. I am trying to get a Russian crab apple. I have some apples grafted on to the native crab apple, and will report whether successful or not in a year or two. I find that the best fertilizers for raising crops on new soil are seaweed and slaked lime and decayed clam shells. I spread plenty of seaweed every fall on my ground and dig it under in the spring, and when planting my potatoes use it in the hills. I distributed the seed I did not use to the natives. It is hard to get them to plant except in the way they are accustomed to, but some of them I have gotten to try cabbage, kale, lettuce, and radishes, and a good many of them are growing different kinds of berries.

Mrs. Annie Baglock, Juneau.—Your kindness in forwarding me seeds bore fruit by supplying us with vegetables all summer and considerable left for fall use. It is wonderful how they grow here, and the size is all that is desired. I find that some varieties are better than others; notably the round radishes and early lettuce do much better than the others. Our cauliflower, cabbage, and beets have been a failure owing to a large green worm that is called here, rightly or wrongly, "army worm." During the last two seasons my rhubarb, spinach, and cress salad went to seed very early from some cause, but all grew well. Kale and turnips came up well, but the worms soon finished them, also the ruta-bagas, and toward the last they tried a let-

tuce diet. My flowers did very well, and I have enjoyed an abundance of them. Of course, you will understand that my flower and vegetable garden is on a comparatively small scale; nevertheless the vegetable garden was quite a help in household affairs, and, being always fresh, the vegetables were relished.

W. H. Marrett, Haines.—In the spring of 1902 I sowed several acres of grain, chiefly oats, but owing to the almost constant rain after the 1st of July they amounted to nothing, and I saved no hay worth mentioning. My potatoes were good, though not at all remarkable. Last spring I had too little confidence to sow much grain again, but a small amount of wheat, barley, and oats near the stable did mature all right. Such garden seed as I could get grew quite well. The radishes, I think, were fully as good as any I have ever seen. My potatoes were excellent and yielded well. I used a 2-horse mowing machine and harvested a good crop of hay, but not nearly so much as I should have done had I anticipated such a fine season as it proved to be.

I did, however, make one crop so superior that I will give quite full particulars. From a small patch of ground near my building I mowed off the grass and fed it out to my horses during the month of June. The last day of the month I plowed and harrowed about half an acre and, without fertilizing at all, sowed turnip seed broadcast July 1. I was away then for a few weeks, and on my return found they were quite large, and so thick that it was difficult to step on any part of the ground without treading on turnips. August 30 I took off 25 sacks, what I could conveniently handle at once. Some of them weighed from 3 to 3½ pounds each, and all who tried them pronounced them the finest and best flavored they had ever seen. On September 10 I marketed as many more and the same amount on September 21. During the next few days I harvested enough to bring the total up to 110 sacks, and still it looked like a good crop. During the first days of October I harvested the balance and to my surprise found that the total was 180 sacks, averaging about 75 pounds. There was not a hollow or woody one in the whole lot. I never ate such delicious turnips before, and though I have traveled extensively in nearly every State and Territory, and considerably in Canada, Mexico, and Europe, I have never before seen any such quantity produced with so little labor or on so little ground. They were chiefly the Early Purple Top. One small package of the seeds was the Golden Ball, and there was about the same amount of the Pomeranian White Globe. These three varieties did about equally well.

H. F. Emmons, Porcupine.—Most of the seeds received were successfully grown. The sample of large beans only blossomed, though I planted them in a warm place. The vines grew 4 feet high and blossomed profusely, but did not produce edible pods. Lettuce, radishes, carrots, and onions grew well. The early cabbage went to seed. The asparagus came up all right. The turnips were very good. The white ruta-bagas ran to small roots. I sent to Bowen's seed house and obtained some yellow ruta-bagas, and they do better here.

I am more and more impressed with the superiority of hill soil for potatoes. My neighbor, Mr. Clark, had a good yield of potatoes, but they are nearly worthless, being full of water and tasteless. I planted the same kind of seed, as we both obtained 200 pounds each of Early Rose from Bowen's seed house, in Seattle, and in the spring my crop raised on Sicle Hill, slate loam, are mealy, crack open when cooked, and are pronounced the best, while Mr. Clark's go begging, and are perfectly worthless. I owned a good farm in Berkshire County, Mass., but never raised finer potatoes, turnips, cabbage, and, in fact, all kinds of vegetables, than right here in Alaska. The soil is rich everywhere. An old, gravelly side hill that one would think would not grow anything is the place potatoes grow and thrive.

W. P. Benn, Skagway.—As to my success in agriculture, my soil is a very sandy loam, composed of decomposed granite and river silt and fertilized with stable manure in moderate proportions, and this is my second year's cultivation. Time of

planting, May 15 to 25. Windsor beans, blood beets, and carrots, excellent growth and good crop; cabbage, three varieties, never saw finer or better quality, many heads weighing 10 pounds each; cauliflower, two varieties, largest and best I ever saw anywhere; celery and lettuce, four varieties, unsurpassed; onions, three varieties, excellent crop, medium size and well matured; parsnips, enormous yield of large roots, high flavor; parsley and spinach, excellent; turnips, ruta-bagas, and radishes, many varieties, finest quality and great yield; tomatoes, strong, vigorous growth, plenty of fruit, but did not mature; cucumbers, strong, vigorous growth, plenty blossoms, but no fruit; summer squash, strong, vigorous growth, small fruit; German wax beans, strong, vigorous growth, small fruit; rhubarb, strawberries, raspberries, gooseberries, and currants, the second season and great success; potatoes, Early Ohio, immense yield, good, dry, and well matured, ripe September 1; Early Rose, immense yield, but poor quality, sweet and watery; Burbank, immense yield, quality medium; Snowflake, large yield, medium size, excellent quality, ripe September. Romanow wheat, Manshury barley, and Burt Early oats, sowed May 20, same soil, fully matured August 20; good average height and yield. Common oats and barley seed from Seattle, sown at the same time and on similar ground, were much better in size of grain, straw, etc., and matured quite as early on a 4-acre tract. The present season was very unfavorable, owing to the unusual rainfall in July and August.

Charles M. Brown, Skagway.—The seeds you sent were a perfect success. I planted what I could of them and gave the rest to my neighbors, who were pleased with them and what they produced. The rhubarb was of the finest quality, and fit to pull long before the season was up; the cabbage was large and good; the carrots and parsnips were excellent in yield and quality; some of them went to the Minneapolis fair. From three short rows of ruta-bagas, about 25 feet long, there were over 400 pounds, all sound and solid; one weighed 16½ pounds after it was trimmed of top and roots; six of them weighed 72 pounds, and all were large. I think we have the happy medium of climatic conditions for gardening in Alaska here in Skagway. Flowers do well here.

L. A. Burke, Skagway.—The seed you sent last year did finely, particularly the cauliflower and cabbage. Of the former I had one which measured 3 feet in circumference and weighed 7 pounds. The carrots, turnips, and ruta-bagas also did well; in fact, everything I planted turned out very successfully.

A. J. Achison, Skagway.—The seeds sent me for experiment have been thoroughly tested and I am much pleased with the results. I have raised over 1,000 pounds of vegetables on a lot 50 by 100 feet, the ground having been cleared last year and stable manure used for fertilizer. The first seeding out of doors was March 31. Lettuce, radishes, and turnips were sown June 3; also some August 10. Peas were sown June 3; also beets, cauliflower, carrots, cabbage, parsnips, Brussels sprouts, cress, potatoes, and mustard. Cabbage, ruta-bagas, turnips, carrots, and potatoes were cultivated but very little, although they matured perfectly. I found lime an excellent fertilizer for beets, but a detriment to peas. The rhubarb grew to a height of 18 inches, and celery matured with scarcely any attention.

John Nyland, Valdez.—I have been advised to write and request that you would kindly furnish me with several varieties of seed both for garden and field culture suitable to this climate. I have taken up a 40-acre tract on the west side of Valdez Bay, about 1 mile southeast of Fort Lisenm, on which I have built a house for myself and family, whom I expect to join me in the spring. I have also done considerable work on the tract in the way of clearing and getting it in order for cultivation as early in the spring as the weather will permit of farm work, as it is my intention to begin farming in dead earnest, and being a Finn and raised on a farm near the border of Sweden up to 1883 until I came to this country, I should and do know something about farming. In a cold climate like this it means hard work and patience, and I

feel and think I will make a success of it in Alaska equal to if not better than in my native land. Since coming to America I have lived twelve years in the Northwest lake country and six years in this part of Alaska. I am a strong, healthy man of 53 years, and am good for twenty years more of active life if no accident befalls me, and by that time I hope to be the owner of both a model Alaska farm and home that will be a credit to both your Department and myself.

Fred Liljegren, Little Naked Island, Prince William Sound.—By request I send you report of what success I had with the seeds you so kindly sent me last spring. My partial failure was no doubt due to the newness of the ground, and as I have only a small spot cleared, about 15 by 30 feet, I did not have a chance to try all of the seeds. Of lettuce and radishes planted May 19 I had two crops in the same benches. Peas, turnips, and ruta-bagas planted the same date did very well. Beets were small and dwarfish. Cabbage only a few headed up. Some potatoes (my own seed) that I planted did very well. The only fertilizer I have used so far is seaweed. Next year my own ground will be in a better condition and I can reasonably expect a bountiful supply of garden truck for family use.

Ed. Edelman, Kenai.—In regard to my garden this summer I am glad to inform you that my potatoes did better than usual. Last spring I got 60 pounds of Early Rose from Mr. H. P. Nielsen, and in addition I had 15 pounds of Burbank. I planted them May 18. The result was 14 sacks. One potato weighed $2\frac{1}{2}$ pounds and many weighed $1\frac{1}{2}$ pounds. Peas and carrots did very well, but ruta-bagas and cabbage not as well as in former years.

A. Lanson, Sunrise, Cook Inlet.—I have the pleasure to report that the seed package sent last year gave good results where the conditions and the soil have been favorable. My principal garden crop has been potatoes, about 2 tons being dug from 175 pounds of seed. When the land was too heavily manured with horse dung the tubers grew rather large and some of them were hollow, but for the main part the crop was all that I could desire. Have sold over 1,000 pounds at 4 cents per pound, and expect to have ready sale for all I can spare. Cabbage and cauliflower did very well. Some heads of cauliflower weighed 7 pounds. Celery did not grow very well, owing perhaps to the soil being new and too sour. Lettuce did the best of all my vegetables. All who saw and used this vegetable pronounced it the finest they ever saw or ate. Some heads weighed about 5 pounds, and from a small piece of ground got enough to supply the whole community. Peas did very well, but could spare for them only a small piece of ground. Radishes were grown in abundance and of the very best kind. Rhubarb made a very good start, and I expect good results next year. Turnips and ruta-bagas did very well; several of the latter weighed 10 pounds apiece. Beets grew large and tender. Tomatoes grew nicely and had an abundance of flowers, but stopped growth when the rains commenced. Will endeavor to have them out earlier and in better soil next year.

The clover and grass seed came up all right, and I hope they will grow. Timothy has grown around my cabin since 1898, and produces seed every year. Clover is springing up wherever I applied manure, so I have no doubt but that it will thrive here. This season I have planted a patch of rye, which now (October) is about 8 inches high, looks fine, and has stooled out nicely.

My land in cultivation this year is little more than an acre, but during the dry part of each year I manage to burn off stumps, roots, and moss from adjoining ground, so increasing the area each season. The soil is rather thin and rocky, except where it has been swampy. The location is about three-fourths of a mile from Sunrise City, where I manage to procure manure from a few pack horses that are kept there in the winter time. So far I am the only one that has tried to raise truck near Sunrise, and in spite of many disadvantages I find it easier and more profitable each year. I am a native of Sweden and know whereof I speak when I assert that this section of Alaska is in many ways superior for general farming to the province where

I was raised and where the population would think themselves very fortunate if they could produce such crops as will grow here. The rich native grasses growing spontaneously wherever the sun gets to the soil, and the abundance of wild fruits to be had here would of itself be inducement enough to entice immigration to this country. This fall I have picked 15 gallons of the little berry known here as the low-bush cranberry, but which I think is called whortleberry in English ("Lingon" in Swedish), and the preserves of which are infinitely superior to any dried or canned fruit in the market. My potatoes grew up to September 24, when the vines were cut down by the frost. Part of my cabbage is out in the garden yet, October 22, 1902, and I believe this season is about the same as the previous years, at least since 1897, when I came here.

A. Lawson, Sunrise, Cook Inlet.—I am sending you samples of the grain raised this season (1903). The barley was harvested in the latter part of August and the other kinds a month later. The rye and wheat you sent me were planted August 29. It is up and looks fine. My vegetables have grown better this year than ever before. (Pl. XIII, fig. 1.) I have as fine a lot of potatoes, turnips, beets, ruta-bagas, parsnips, and carrots as you will see anywhere. My crop of early cabbages and cauliflowers is sold off. Some of my cabbages weighed up to 12 pounds. I am reasonably certain that rye, wheat, barley, and oats, also the various grasses, can be grown to perfection as soon as the seeds shall have become sufficiently acclimated. The first frost occurred here September 23, and potato vines were killed September 27.

G. M. Palmer, Knik, Cook Inlet.—The seeds I did not use myself were distributed among the natives, and some of them raised quite a number of potatoes, turnips, and beets. Of course the ground is new yet and there is no fertilizer here, so the yield is small, but it is a help to them.

My own garden was not as good as last year, as I was away during June and most of July. Of the seeds I planted, cabbage, kale, cress, lettuce, and cauliflower did well. Turnips and ruta-bagas were a partial success, due only to lack of attention. Beets came up and all went to seed. Parsnips and carrots did not come up. Radishes grew finely, but there is a white worm here that eats into the roots and stops the growth. The top appears to grow all right, but the root will be only about as large as a large bean, and the worm will be inside.

G. Roll, Hope City, Cook Inlet.—I am sending you samples by this mail of Bort Extra Early oats, Mansbury barley, Romanow Spring wheat, Silver Hull buckwheat, and Broad Windsor beans. The above-named cereals were planted May 17 in new soil. It was rather dry at the time they were planted, therefore they made a very poor start, and it continued so until July 3, and we have had very little rain from then up to the present time. Last year the grain we had was much better; more matured than the samples we send you by this mail.

The Windsor beans planted May 31 were in blossom by July 10. We also planted Improved Golden Wax beans on May 31. They were in bloom by July 10, and were eatable by August 13. This is the first year we have had good marketable string beans, and potatoes are larger and better than any year heretofore. Onions have never been a success. All other vegetables, such as cabbage, cauliflower, turnips, ruta-bagas, beets, carrots, parsnips, radishes, lettuce, and peas do well, just as well as in any part of the United States. (Pl. XIII, fig. 2.)

D. W. Hareey, Tyonek.—This is my third season at Tyonek. Last year I was successful with all kinds of garden vegetables. This season was late, frost remaining in the ground until May 20. On May 20 I planted lettuce, radishes, onions, parsnips, beets, carrots, ruta-bagas, and peas, and on May 28 potatoes. White Dutch turnips, sown May 28, were ready for the table July 20. I had peas ready for the table this year August 25. Cabbage is also ready for the table at this date, September 6; beets also. Early peas do the best. Of the turnips tried White Dutch is the best. Purple Top lettuce has the largest heads. Rhubarb does well, the largest I ever saw was raised

from the seed you sent me two years ago. Potatoes do splendidly, especially Early Rose and Burbank, and of cabbage Early York and Jersey Wakefield. The last named has the largest heads. I had one for dinner that weighed 10 pounds, and have 50 more the same size.

J. C. Smith, Sineconoffsky.—I have planted in my garden this year potatoes, cauliflower, cabbage, beans, peas, Brussels sprouts, and turnips. Everything is doing well. My cabbage, cauliflower, potatoes, and turnips can not be beat in the country. The oats and barley have matured all right, but the weather will not allow them to dry. This is the worst summer for wind and rain that has been seen here for the last ten years. The grasses you sent me have done well, especially the rye grass and clover. I have quite a cattle ranch here of 25 head of first-class cattle.

Henry S. Tibbey, Coal Harbor.—I prepared a small clearing in an old grove that had been the year previous planted in turnips, and after fertilizing it well with seaweed, on May 11, planted in subdivisions Romanow wheat, Ladoga Spring wheat, Manshury barley, and Finnish barley, being the seed that you sent me. In one month from the date of planting the Romanow wheat and Manshury barley were 18 inches above the ground. By last mail I sent you a sample of the barley, and by this steamer mail you a sample of the wheat as pulled from the ground on September 11 and 20, respectively. The Ladoga wheat and Finnish barley did not succeed quite as well as the other two. Next year I should like to plant at least an acre each of Romanow wheat and Manshury barley, if you will advise me where the seed can be purchased.

Mrs. Emma H. Rock, Carmel, Nushagak post-office.—There are four or five native gardens in this village, planted mostly in turnips; some carrots, ruta-bagas, and peas; also potatoes. All natives are very fond of turnips, but it is considered almost too much trouble to raise them. Everything must be carefully fenced, for there are many dogs. The mission has a large and very fine garden. All the white settlers at this village—seven in number—have cultivated a patch, planted mainly in potatoes. They also raise some of the smaller vegetables, as turnips, ruta-bagas, cabbage, and a few onions. Potatoes, ruta-bagas, peas, radishes, lettuce, carrots, kohlrabi, and kale succeed very well in this climate; others, such as onions, beets, rhubarb, and all cereals (not including corn, for that is a failure), would like a little warmer and a longer season.

Taking in all there has been a very marked improvement in agriculture in this district during the past five years, for which the mission can honestly take much credit. First we went ahead and made a success of gardening ourselves, then we gave out seeds of all kinds and showed and encouraged our neighbors, as well as the natives, how to use them.

J. H. Romig, Ougavig, Kuskokwim River.—The soil at the station of Ougavig is a deep loam, and very productive of red top and other wild grasses. The soil is warm and ready for the planting of seeds, and the transplanting of hotbed plants by the 1st of June. In former years the latter part of May.

Early Jersey Wakefield cabbage has given the best satisfaction, and has matured in large, very crisp and delicious heads. The seed was planted in the hotbed early in April and transplanted the 1st of June. Early Egyptian and Early Blood Turnip beets were planted in the hotbed April 11, and transplanted early in June. By the end of August the beets had matured and could have been used before that date. They were from 2 to 3 inches in diameter and of most excellent quality. The French Breakfast and Early Scarlet radishes were the varieties planted. They rapidly matured and were of most excellent quality. Planted in open ground late in May, and at intervals of a few weeks until August. Purple Top and Early White Milan turnips, and a yellow variety, name not known, did very well, were large, and of a most delicious quality. This is the land of turnips. They were planted in May in the open ground. Yellow and white ruta-bagas planted in the hotbed in April and



FIG. 1.—ALASKA STATIONS—MR. A. LAWSON'S GARDEN, SUNRISE, COOK INLET, AUGUST 15.



FIG. 2.—ALASKA STATIONS—CABBAGE AND POTATOES AT HOPE, COOK INLET, AUGUST 16.

transplanted to open ground the first part of June, grew large and were of excellent quality. Early Half Long carrots planted in the hotbed the first part of April and transplanted in the early part of June, matured well, and by the latter part of August the bulbs were from 1 to 1½ inches in diameter. Hollow Crown parsnips was the only variety planted. Planted in hotbed the first part of April, and transplanted 1st of June. The largest roots reached the size of 1½ inches in diameter. Large Hanson, Early Prize Head lettuce, and many other varieties did very well. Were planted in hotbed and in open ground from early spring to the middle of June. All did well and can be scarcely surpassed for quality and size. An early variety of peas planted in open ground about the 1st of June, did well, and peas were of good quality for table use. Black wax beans, planted in hotbed the middle of April and transplanted to open ground the middle of June, though not a success as in warmer climates; green beans of excellent quality were raised for table use by August 20. Extra Early Erfurt cauliflower, planted in hotbed early in April and transplanted early in June, gave a few good heads.

Among field crops, two varieties of oats were sown, just to have something that looks like the States growing in the garden besides the vegetables. The seed was planted late in May in the open ground. The growth of the straw was equal to any in the States, and some of the seed matured, but the plant was green when the frost killed it early in September. A year or so since a small plat of buckwheat was planted as described for the oats above. The yield was very good, but many of the grains were caught by the frost while only partially filled out.

A. C. Karlsson, *Unalakleet*.—The garden work has been very successful this year owing to the early spring and warm summer. The varieties raised were potatoes, ruta-bagas, turnips, parsnips, carrots, radishes, cabbage, lettuce, rhubarb, spinach, peas, and beans. Some of the turnips were quite large, weighing up to 11 pounds. The peas did nicely, but the beans failed. I seeded some turnips and carrots, but the latter did not ripen before the frost came. I experimented with some oats, and it did grow to maturity. I also tried other seed besides the above mentioned, but it never came up—probably too old.

I beg leave to call special attention to the following report from Mr. John A. Dexter, of Golovin. This little settlement is located on Golovin Bay, north of latitude 64° and not very far from Nome, in a treeless, wind-swept region, and surrounded by the icy waters of Bering Sea. In the light of these facts, the results reported by Mr. Dexter seem little short of miraculous.

John A. Dexter, *Golovin Bay*.—I began gardening June 6, 1901, at Chinik or Golovin, not far from Nome, and have continued every year, and have been successful with the following: Lettuce, radishes, carrots, peas, parsnips, turnips (small white), ruta-bagas, sage, thyme, marjoram, potatoes, onions, leek, beets, spinach, kale, chicory, water cress, pepper grass, chives, cauliflower, cabbage, oats, and barley.

The last three summers my gardens have exceeded my expectations. Last summer some of my ruta-bagas weighed 8½ pounds, and six varieties of turnips were all of a fine size and excellent flavor. Lettuce raised in this section excels any I have ever eaten. I have also raised as high as five crops of radishes in a season. The lettuce we cut instead of pulling it by the roots, and in less than a week it is large enough to cut again; some heads measuring 26 inches around, and weighing 2½ pounds. Carrots grow splendidly. I find that the Short Horn, and several other hardy varieties, grow to be quite large, and for table use are far superior to the carrots raised on the coast. The average size is about 2½ inches around and 6 inches long.

Oats also grow fine and ripen. I planted a piece of ground 20 by 16, and it was the prettiest piece of oats ever seen. It grew 4 feet tall, and the oats were heavy and in

every way developed. I sincerely believe that Alaska could produce enough oat hay to feed a very large amount of stock. There is one drawback for raising it for grain; some seasons are very rainy, but to cut during the month of July, there is nothing better for hay. Potatoes grew very well last season. The frost destroyed the tops on the 2d of September, retarding the growth; still some of my crop weighed 1 pound and averaged about 3 to the pound.

My garden is the only one in this section, but at Nome there are quite a number who raised radishes and lettuce and did a fine business supplying restaurants and hotels at 50 cents per head of a few leaves. My garden of $2\frac{1}{2}$ acres is situated on a point on the north shore of Golovin Bay and is exposed to all of the strong gales, being only 60 yards from the beach, and has Golovin Bay on the south and Golovin Sound on the north. The soil is a sandy loam and is rarely fit for planting before the 1st of June. I have not tried hotbeds or hothouses, raising everything from seed planted in the open air and using very little fertilizer. I consider this section much better adapted to agricultural pursuits than parts of Norway and Sweden, and I can see no reason why Alaska can not produce nearly all her vegetables needed. The Yukon Valley is as good a farming country as the northern part of Minnesota, in fact taking the long summer day with 20 hours of sunshine, it makes a pretty fair growing season.

During the past season I raised 500 pounds of carrots, 2,500 pounds of turnips, 2,000 pounds of potatoes, 300 pounds of parsnips, 150 pounds of onions, and other vegetables in abundance, also sweet peas for flowers. I also keep 2 horses, 2 cows, 1 bull, cutting all the feed here, except oats for the horses; 5 pigs, raised from April to October, averaged 150 pounds and were only fed one month before killing time, and 2 goats, which were killed by the dogs.

Mrs. Charles P. Phillips, Council City.—The seed you sent last year I used this spring. I could not begin to use all of the lettuce. I have given it away to all friends, also radishes. I planted carrots, parsnips, turnips, radishes, mustard, beets, onions, three kinds of lettuce, sweet peas and nasturtiums, all in three beds, inclosed with a fence about 18 feet square. It is a small place to call a garden, but I get lots of green food from it. Now, as to the way we grow the plants. We put down large logs and fill them level with stable manure, then 6 inches with black soil, about 4 inches of sand or wash from the river. I have had this garden three summers. Last year we filled it level with manure and put the old soil on top with the dirt. The manure is in the bottom and keeps it warm and, as none of the things I desire have long roots, it does not burn them. The ground is so cold and it is the only way I can see to form a heat under plants.

I am the only one in this part of the country that tries to have a garden, and I could not get along without it. The first lettuce I planted was on May 1 and on July 4 had nice lettuce for dinner. Last fall I took in the house six heads half grown and kept in the window until Thanksgiving day and had it for dinner, and it was a treat. I had some nice large turnips and beets last season.

J. A. Morgan, Dawson, Y. T.—You will find with this letter some samples of oats, wheat, and barley that were grown here from the seed you sent us. We planted it on May 22, and by July 20 the barley was 47 inches high, the wheat 45 inches, and the oats 42 inches. It was ripe September 1, and at that time the wheat was 47 inches high, barley 45 inches, oats 42 inches. From the way it did I should think it would go about 60 bushels to the acre. The vegetables did finely. From the Jersey Wakefield cabbage you sent us we got heads that weighed 12 pounds, and none less than 6 pounds. We started those and cauliflower in the house the 1st of April, and set them outdoors the 1st of June. We had Early Snowball cauliflower that weighed 3 pounds, and none less than 1 pound. The Purple-Top Strap-Leaf turnips did not get very large, but were nice and tender. They were planted the 1st of

June and we had some the last of July. Laing Improved ruta-bagas were quite large, the largest weighing $2\frac{1}{2}$ pounds. They were nice and tender. They were planted at the same time, but we did not have any until September 1. Early Scarlet Horn carrots did nicely. They were about 8 inches long and about 3 inches in diameter. Ready for the table about August 20. Onions were only good for young onions. Egyptian beets got quite large, some being 3 inches in diameter. Early Market and Alaska peas yielded finely. They grew about 14 inches high. We also planted some Atlantic Prize tomatoes outdoors. The plants grew about 20 inches high, and bore so many tomatoes they had to be propped up with sticks. They were all ripe by the 1st of September. From 15 sacks Early Rose potatoes we got 250 sacks, and they were as nice as could be grown anywhere; some weighed 2 pounds.

Peter Lundine, Eagle.—The three kinds of wheat, barley, and oats matured perfectly. The wheat reached a height of 5 feet; the oats, some as high as $5\frac{3}{4}$ feet; and barley, 5 feet. The turnips and cabbage also did well, but prefer the Yellow Globe turnip for this climate. I raised 100 sacks of potatoes on three-fourths of an acre of ground. This year I planted 4 acres of Early Rose potatoes. I now have 5 acres in cultivation. Have a house, 3 cows, 2 calves, and several pigs. This year I built a double log barn, and, if expectations don't fail, by this coming fall I shall have a large silo.

John H. Robinson, Circle.—Mr. E. E. Reynoldson, chief office deputy marshal, and myself cultivated a garden this year, using Department seeds, and will give you a report as to growth, etc.

Early Jersey Wakefield cabbage does not prove to be the most suitable for the Yukon; they mature too early and burst open, and so will not keep during the summer. The Flat Dutch and Drumhead varieties seem better adapted to our conditions. Turnips grew well and large; we had some 8 or 9 pounds in weight and $27\frac{1}{2}$ inches in circumference. Our beets were the best in Eagle, three of them averaging 4 pounds in weight, and were as fine as could be seen anywhere in the world. Parsnips grew more tops than roots, but attained 4 or 5 inches in length and 2 inches largest circumference. Carrots were excellent, large, firm, and well matured. Cauliflower matured too early, but were large. Peas were excellent, bearing large and continuously. Garden beans, large flat, we tried, and they can be grown well, pods averaging 4 to 5 inches and well filled. Celery not grown. Radishes fair. Lettuce good. We grew enough vegetables for two families in lot 50 by 100 feet this summer; also about 5 bushels of potatoes.

By the way, the people in Dawson gave an exhibition of vegetables on the Yukon this monthand, for outside of Dawson districts, Father Monroe, of the Jesuit Mission, received first prize for assortment of vegetables, and Reynoldson and Robinson, of Eagle, second prize.

George F. Bemis, Circle.—I enclose you samples of peas and barley which I raised from the above seeds furnished by you. I experimented also with cabbage; the Early York was very hard and of fine quality, weighing from 4 to 6 pounds. I raised from 8 pounds of potatoes which were planted this year 126 pounds. My rhubarb stood the winter and came up this spring, and the leaves are fine. Carrots, parsnips, turnips, ruta-bagas, cress, Brussels sprouts, beets, string beans, and all such truck I have raised with good results, as have also others to whom I have distributed the seed. Red and alsike clover lived through the winter and came up in good shape. The latter kind I think did the best. I feel satisfied that millet and timothy would do well if you would send some; also several kinds of small fruit—strawberry, raspberry, etc.

Last year I did not water any of my truck, but resorted to a more extensive use of the hoe, and found it all right, and am following the same plan this year. Since

planting my first little garden in 1898, at Circle, I have shown to the people that very many things can be raised here that was at that time thought impossible, and, as a result, at least 15 or 20 acres are in grain and vegetables about town this year.

Edward J. Knapp, St. Andrew's Mission, Rampart.—Mr. B. A. Knott, an old German miner who has been here for several years and has taken considerable interest in gardening, planted a garden this year in which he grew a variety of vegetables—peas, bush beans, and garden beans, white and purple top turnips, beets, ruta-bagas, cabbage, kale, lettuce, radishes, celery, carrots, parsnips, potatoes, and parsley, a great variety, some of which did very well indeed. On a piece of ground 25 by 40 feet he gathered a crop of turnips that weighed nearly if not quite a ton. Some of the roots weighed over 6 pounds. Some of his potatoes reached a fair size, though many were very small. The cabbage headed well, but did not grow large. The kale developed quite well, growing plants that spread to a diameter of 30 inches. The cabbage and some of the kale were started in the late spring indoors, but kale planted later out of doors did better than that the growth of which was forced. Some of the turnips, too, that were planted late grew quickly and developed better than those transplanted earlier. The ruta-bagas did not do very well, nor did the beets, parsnips, or carrots. The celery grew only about 8 inches tall. The peas did very well; so did the bush beans. The garden beans did poorly, though they bore. The lettuce, especially the red variety, did well.

Mr. Knott took much interest in his garden and worked at it hard. The early part of the season was very dry, and this set back the growth of the plants. The water had to be carried daily from the creek to the top of the bench until the plants got well rooted. Some of the soil cultivated by Mr. Knott was new. A part of it he treated with ashes and got good results wherever the ashes were used. There was no severe frost here until the latter part of August.

A. H. Monroe, Rampart.—American Wonder peas planted in the latter part of June in very good soil on a bench or bar about 20 miles from the mouth of Baker Creek and 80 miles up the Tanana from Fort Gibbon grew fine and were full of blossoms, and a few pods beginning to fill by the last of August. Silver Hull buckwheat was doing excellent, about 3 to 3½ feet high, and seed forming, doing well, some in the dough. Mustard, some as high as 3 feet and seed pods well filled. Some of the lettuce was very large and tender. The onions came up but only a few lived, and they got about one-fourth of an inch in diameter. The carrots and parsnips did not come up. The cabbage got about 3 inches high. The kale got about 10 inches high and had some very nice leaves. The Purple-Top Strap-Leaved turnip did well. The white turnips went more to leaves. The ruta-baga is most too slow a grower for this country, I think, although some got as large as 2 inches in diameter.

The experiment station at Rampart did very well in raising grain. I visited the station with Mr. J. W. Duncan, and the wheat was well headed and well filled with large plump grain. The black oats, some of which was 6 feet high, had long heads well filled. The rye was sown too thick, but the grains are as nice as I ever saw. I saw both beets and parsnips that lived in the ground over winter where they grew and had gone to seed, and the seed seemed to mature all right.

E. T. Townsend, Rampart.—There have been several very successful gardens here this summer, and I have heard several speak of planting extensively next summer. One thing is sure, that any garden planted early and but slightly tended will yield large returns, if planted on reasonably good soil.

Mr. Knott and Mr. E. J. Knapp planted quite a large garden at Rampart, and had remarkable success with all of the ordinary vegetables, harvesting more than a ton of turnips. I saw some of the grain, barley, wheat, oats, buckwheat, etc., which grew on the Government farm (so called) this summer, and it was remarkably fine, with large plump heads and very rank.

J. F. Karlsruer, Baker Creek Station.—I have a fine locality as to soil and lay of land, facing the south on a large flat. It is about 6 miles from the Tanana River and about the same distance from Baker Creek Station. It is tempered by hot springs, which is no small affair, for they spread along the stream for a mile, hot and warm water oozing out and forming three small streams which empty into a creek into the Tanana.

The seeds you sent me were in fine condition and fresh, as all came up. I received a fresh package from the States in time to get in early. I had lettuce, radishes, peas, beets, carrots, and turnips, all large enough to eat by July 4. In fact the lettuce and radishes were large enough to eat by the last of June.

I wish you could see my garden as it looks now (August 22). Cabbage heading beautifully; potatoes in full bloom, and a late kind at that. If I had had Early Rose I think I would have had potatoes large enough to eat by this time. Cucumbers and tomatoes are doing finely. The California squash is looking remarkably well. The squashes are as large as my head. Turnips that a few weeks ago weighed 4 pounds are now as large as a man's head. The rutabagas are simply enormous, and potatoes are filling out as well as I ever saw them. I have never seen vegetables grow as they do around the springs. I had no frost here when it was freezing at Baker Creek Station. I planted peas, beets, radishes, turnips, and lettuce April 20, and they were up May 1, and no frost to hurt them, though there was 3 feet of snow on the benches only a short distance away. I appreciate the difference in the climate, and the heat on the ground one had to see to believe.

J. L. Lucchesi, S. J., Holy Cross Mission, Koserefsky.—In general, results were encouraging. The potatoes, Early Rose, are larger and better than ever. Soggy potatoes are getting rare. We have such an abundance that, besides supplying this large institution and outlying missions, we have enough to feed the cows. All the other vegetables that are usually grown here have given their wonted satisfaction. Even tomatoes, though tried for the first time, were fit for table use. They were pulled green, however, as they had not time or heat enough to ripen.

We are still trying the grains, and by the samples sent you you will see that oats and buckwheat are not far from success. As yet but few matured seeds on the ears, but we hope by planting these seeds, grown in the country, that the ears will mature more and more each succeeding season as the seed becomes acclimated. Corn failed, owing to having the wrong brand of seed, I think. As for the hay crop, we have more than enough, and our herd, more than doubled since you were here, need have no fears of going hungry the coming winter. Clover blossoms for the first time adorned our fields this summer. In fact it is hard to realize that this spot, once covered with trees, brush, and moss, could in so short a time be brought to its present fruitful and beautiful state.

One of the sisters at Holy Cross Mission.—In the spring of 1902 we planted some Broad Windsor and Lima beans and both did well. We distributed much seed among the Indians of this village and in Piment, and they seemed quite in earnest to start little gardens, but the great drawback is the scarcity of tools. We are lending ours to the Indians around this village whenever we can, and it is a great encouragement.

SOIL TEMPERATURES.

Readings, taken at 7 a. m., in degrees Fahrenheit. Thermometers planted 6 and 24 inches deep, respectively. Radiation thermometer shows the daily minimum temperature 6 inches above surface of ground.

Soil temperatures.

SITKA EXPERIMENT STATION.

Day.	6-inch ther- mome- ter.	24-inch ther- mome- ter.	Radia- tion ther- mome- ter.	Day.	6-inch ther- mome- ter.	24-inch ther- mome- ter.	Radia- tion ther- mome- ter.	Day.	6-inch ther- mome- ter.	24-inch ther- mome- ter.	Radia- tion ther- mome- ter.
1903.	° F.	° F.	° F.	1903.	° F.	° F.	° F.	1903.	° F.	° F.	° F.
May 8 ..	45.0	40.5	35.0	July 1...	54.0	50.0	45.0	Aug. 24 ..	58.0	54.0	39.0
May 9 ..	44.0	40.5	32.0	July 2...	54.0	50.0	44.0	Aug. 25 ..	58.0	53.5	38.0
May 10 ..	43.5	41.0	32.0	July 3...	51.0	50.0	44.0	Aug. 26 ..	57.0	54.0	44.0
May 11 ..	43.5	41.5	32.0	July 4...	54.0	50.0	39.0	Aug. 27 ..	57.0	54.5	37.0
May 12 ..	44.0	41.5	34.0	July 5...	54.0	50.0	38.0	Aug. 28 ..	56.0	54.0	34.0
May 13 ..	45.0	42.0	33.0	July 6...	55.0	50.0	39.0	Aug. 29 ..	56.0	53.5	31.0
May 14 ..	45.0	42.0	32.0	July 7...	56.0	50.5	40.0	Aug. 30 ..	56.0	54.0	34.0
May 15 ..	44.0	42.0	31.0	July 8...	56.0	50.5	40.0	Aug. 31 ..	57.5	54.0	31.0
May 16 ..	45.5	42.0	30.0	July 9...	55.0	50.5	45.0	Sept. 1 ..	56.0	53.0	34.0
May 17 ..	46.0	42.5	29.0	July 10...	55.0	50.5	40.0	Sept. 2 ..	56.5	54.0	32.0
May 18 ..	47.0	42.5	36.0	July 11...	57.0	51.0	40.0	Sept. 3 ..	55.5	54.0	30.0
May 19 ..	46.0	42.5	34.0	July 12...	55.0	51.0	40.0	Sept. 4 ..	55.0	53.5	31.0
May 20 ..	46.0	42.5	30.0	July 13...	56.0	51.0	38.0	Sept. 5 ..	56.0	53.5	32.0
May 21 ..	46.0	43.0	28.0	July 14...	56.0	51.0	33.0	Sept. 6 ..	56.0	53.5	31.0
May 22 ..	46.5	43.5	29.0	July 15...	55.5	51.5	45.0	Sept. 7 ..	55.0	53.0	37.0
May 23 ..	46.5	43.5	32.0	July 16...	56.0	51.5	56.0	Sept. 8 ..	55.0	53.0	32.0
May 24 ..	46.5	43.5	39.0	July 17...	56.0	51.5	56.0	Sept. 9 ..	56.0	53.5	34.0
May 25 ..	46.5	43.5	32.0	July 18...	56.0	51.5	56.0	Sept. 10 ..	55.0	53.5	34.0
May 26 ..	46.5	43.5	36.0	July 19...	55.0	51.5	44.0	Sept. 11 ..	54.0	53.5	33.0
May 27 ..	47.0	44.0	37.0	July 20...	54.0	52.0	48.0	Sept. 12 ..	56.5	53.5	34.0
May 28 ..	47.0	44.0	32.0	July 21...	53.0	52.0	45.0	Sept. 13 ..	56.0	53.0	34.0
May 29 ..	48.0	44.5	38.0	July 22...	55.0	52.0	34.0	Sept. 14 ..	53.0	52.5	38.0
May 30 ..	48.0	44.5	40.0	July 23...	56.0	52.0	34.0	Sept. 15 ..	53.0	52.0	38.5
May 31 ..	48.0	44.5	39.0	July 24...	56.0	52.0	33.0	Sept. 16 ..	53.0	52.5	44.0
June 1 ..	48.0	44.5	35.0	July 25...	57.0	52.0	36.0	Sept. 17 ..	53.0	52.0	40.0
June 2 ..	48.0	44.5	37.0	July 26...	55.0	52.0	34.0	Sept. 18 ..	52.5	52.0	36.0
June 3 ..	48.0	44.5	38.0	July 27...	56.0	52.0	36.0	Sept. 19 ..	54.0	52.0	34.0
June 4 ..	48.5	44.5	32.0	July 28...	57.0	53.0	45.0	Sept. 20 ..	50.0	52.0	30.0
June 5 ..	49.0	45.0	32.5	July 29...	56.0	52.0	40.0	Sept. 21 ..	50.5	51.5	29.0
June 6 ..	49.5	45.0	38.0	July 30...	56.0	53.0	42.0	Sept. 22 ..	51.5	51.0	26.0
June 7 ..	50.0	45.5	40.0	July 31...	57.0	52.5	41.0	Sept. 23 ..	49.0	51.0	36.0
June 8 ..	52.5	46.0	46.0	Aug. 1 ..	56.0	52.5	40.0	Sept. 24 ..	49.0	51.0	29.0
June 9 ..	52.5	46.0	46.0	Aug. 2 ..	56.0	53.0	36.0	Sept. 25 ..	49.0	51.0	34.0
June 10 ..	52.5	46.0	41.0	Aug. 3 ..	56.0	53.0	37.0	Sept. 26 ..	49.0	50.5	33.0
June 11 ..	52.5	46.0	42.0	Aug. 4 ..	58.0	53.0	35.0	Sept. 27 ..	48.5	50.5	30.0
June 12 ..	52.0	46.0	30.0	Aug. 5 ..	59.0	53.0	39.0	Sept. 28 ..	50.0	51.5	31.5
June 13 ..	52.0	46.0	32.0	Aug. 6 ..	60.0	53.0	39.0	Sept. 29 ..	49.5	51.0	33.0
June 14 ..	52.0	47.0	44.0	Aug. 7 ..	59.0	53.5	39.0	Sept. 30 ..	50.0	50.5	31.0
June 15 ..	52.5	47.0	42.0	Aug. 8 ..	59.0	53.0	45.0	Oct. 1 ...	48.0	50.5	20.0
June 16 ..	52.5	47.5	40.0	Aug. 9 ..	56.0	52.5	44.0	Oct. 2 ...	46.5	50.0	19.0
June 17 ..	53.5	47.5	35.0	Aug. 10 ..	58.0	54.0	46.0	Oct. 3 ...	45.5	49.5	19.0
June 18 ..	53.5	47.5	40.0	Aug. 11 ..	58.0	54.0	47.0	Oct. 4 ...	48.0	50.0	23.0
June 19 ..	55.0	47.5	45.0	Aug. 12 ..	57.0	54.0	45.0	Oct. 5 ...	46.5	49.0	26.0
June 20 ..	55.5	48.0	40.0	Aug. 13 ..	58.0	53.5	39.0	Oct. 6 ...	45.5	49.0	31.0
June 21 ..	55.5	48.5	40.0	Aug. 14 ..	57.5	54.0	35.0	Oct. 7 ...	46.0	49.5	32.0
June 22 ..	55.5	48.5	43.0	Aug. 15 ..	57.0	54.0	31.0	Oct. 8 ...	46.5	49.0	26.0
June 23 ..	55.5	49.0	43.0	Aug. 16 ..	58.0	54.0	34.0	Oct. 9 ...	45.0	49.0	23.0
June 24 ..	55.5	49.5	45.0	Aug. 17 ..	58.0	53.5	34.0	Oct. 10 ..	45.5	49.0	25.0
June 25 ..	55.0	49.5	44.0	Aug. 18 ..	58.0	53.5	38.0	Oct. 11 ..	45.0	49.0	26.0
June 26 ..	55.0	49.5	42.0	Aug. 19 ..	59.0	54.0	40.0	Oct. 12 ..	45.5	49.0	30.0
June 27 ..	54.0	49.5	40.0	Aug. 20 ..	57.0	54.0	45.0	Oct. 13 ..	46.0	49.0	30.5
June 28 ..	54.0	49.5	42.0	Aug. 21 ..	57.0	52.0	44.0	Oct. 14 ..	45.0	49.0	30.0
June 29 ..	54.0	49.5	42.0	Aug. 22 ..	58.0	54.0	41.0	Oct. 15 ..	44.0	47.0	31.0
June 30 ..	54.0	50.0	45.0	Aug. 23 ..	58.0	54.0	41.0				

COPPER CENTER EXPERIMENT STATION.

1903.	° F.	° F.	° F.	1903.	° F.	° F.	° F.	1903.	° F.	° F.	° F.
May 1 ..	33.0	31.0	31.0	May 17 ..	38.0	32.0	23.0	June 2 ..	44.0	38.0	28.0
May 2 ..	34.0	31.0	29.0	May 18 ..	40.0	32.5	30.0	June 3 ..	44.0	38.0	26.0
May 3 ..	34.0	31.0	22.0	May 19 ..	42.0	32.5	32.0	June 4 ..	42.0	38.5	35.0
May 4 ..	35.0	31.0	29.0	May 20 ..	41.0	33.0	26.0	June 5 ..	42.5	38.0	29.0
May 5 ..	35.0	31.5	27.0	May 21 ..	41.0	34.0	32.0	June 6 ..	43.0	38.5	37.0
May 6 ..	36.0	31.5	26.0	May 22 ..	40.0	34.0	33.0	June 7 ..	45.0	38.0	35.0
May 7 ..	36.0	31.5	22.0	May 23 ..	39.5	34.5	18.0	June 8 ..	50.0	40.0	38.0
May 8 ..	36.0	31.5	27.0	May 24 ..	40.0	34.5	36.0	June 9 ..	50.0	40.0	28.0
May 9 ..	36.0	31.5	24.0	May 25 ..	40.0	35.0	33.0	June 10 ..	50.0	41.0	27.0
May 10 ..	35.5	31.5	21.0	May 26 ..	41.0	35.0	27.0	June 11 ..	49.0	41.0	31.0
May 11 ..	35.0	31.5	23.0	May 27 ..	42.0	35.5	24.0	June 12 ..	49.0	41.5	31.0
May 12 ..	37.0	31.5	31.0	May 28 ..	41.0	36.0	21.0	June 13 ..	52.0	42.0	42.0
May 13 ..	39.0	32.0	27.0	May 29 ..	41.5	36.5	22.0	June 14 ..	51.5	42.5	42.0
May 14 ..	40.0	32.0	46.0	May 30 ..	42.0	37.0	28.0	June 15 ..	48.5	42.5	32.0
May 15 ..	41.0	32.0	38.0	May 31 ..	46.0	37.5	39.0	June 16 ..	50.0	42.5	39.0
May 16 ..	38.0	32.0	25.0	June 1 ..	44.0	38.0	36.0	June 17 ..	50.0	43.0	29.0

Soil temperatures—Continued.

COPPER CENTER EXPERIMENT STATION—Continued.

Day.	6-inch ther- mome- ter.	24-inch ther- mome- ter.	Radia- tion ther- mome- ter.	Day.	6-inch ther- mome- ter.	24-inch ther- mome- ter.	Radia- tion ther- mome- ter.	Day.	6-inch ther- mome- ter.	24-inch ther- mome- ter.	Radia- tion ther- mome- ter.
1903.	° F.	° F.	° F.	1903.	° F.	° F.	° F.	1903.	° F.	° F.	° F.
June 18.	50.0	43.0	38.0	July 22.	53.0	48.5	36.0	Aug. 25.	52.5	50.5	44.0
June 19.	50.0	45.0	40.0	July 23.	52.5	48.5	30.0	Aug. 26.	47.5	50.0	24.0
June 20.	53.0	45.0	44.0	July 24.	54.0	48.5	30.0	Aug. 27.	47.5	49.5	20.0
June 21.	57.0	46.0	36.0	July 25.	55.0	49.0	29.0	Aug. 28.	45.0	49.0	16.0
June 22.	59.0	47.5	42.0	July 26.	57.0	49.5	40.0	Aug. 29.	46.0	48.5	33.0
June 23.	57.5	47.5	44.0	July 27.	56.0	49.5	46.0	Aug. 30.	43.0	48.5	19.0
June 24.	55.0	48.0	34.0	July 28.	57.0	50.0	47.0	Aug. 31.	44.0	48.5	20.0
June 25.	55.0	47.0	42.0	July 29.	56.0	50.0	47.0	Sept. 1.	42.5	48.0	16.0
June 26.	50.0	47.0	40.0	July 30.	55.0	50.0	30.0	Sept. 2.	43.0	47.5	18.0
June 27.	50.0	46.5	39.0	July 31.	55.0	50.0	33.0	Sept. 3.	44.0	46.5	11.0
June 28.	52.5	46.5	38.0	Aug. 1.	55.5	50.5	28.0	Sept. 4.	42.5	46.0	11.0
June 29.	52.0	46.5	37.0	Aug. 2.	57.5	50.5	46.0	Sept. 5.	42.0	46.0	17.0
June 30.	53.0	46.5	36.0	Aug. 3.	57.0	50.5	47.0	Sept. 6.	44.5	46.0	22.0
July 1.	55.0	47.0	31.0	Aug. 4.	56.0	50.5	48.0	Sept. 7.	45.0	46.0	35.0
July 2.	55.0	47.0	47.0	Aug. 5.	56.0	50.5	42.0	Sept. 8.	44.0	46.0	31.0
July 3.	50.5	47.5	30.0	Aug. 6.	52.5	50.5	27.0	Sept. 9.	41.0	46.0	10.0
July 4.	57.0	47.0	41.0	Aug. 7.	53.0	50.0	31.0	Sept. 10.	41.5	46.0	11.0
July 5.	55.0	47.0	35.0	Aug. 8.	57.5	50.0	47.0	Sept. 11.	40.5	45.5	13.0
July 6.	57.0	48.0	45.0	Aug. 9.	57.5	50.5	48.0	Sept. 12.	41.0	45.0	18.0
July 7.	59.0	48.5	53.0	Aug. 10.	57.0	50.5	45.0	Sept. 13.	43.0	45.0	36.0
July 8.	58.0	49.0	46.0	Aug. 11.	55.0	50.5	40.0	Sept. 14.	44.0	45.0	46.0
July 9.	58.0	49.0	45.0	Aug. 12.	55.0	50.5	33.0	Sept. 15.	42.0	45.0	41.0
July 10.	56.0	49.0	30.0	Aug. 13.	56.0	50.5	28.0	Sept. 16.	45.0	45.0	33.0
July 11.	57.5	49.0	40.0	Aug. 14.	55.0	50.5	29.0	Sept. 17.	42.5	45.0	26.0
July 12.	55.0	49.0	24.0	Aug. 15.	53.0	50.5	28.0	Sept. 18.	42.5	44.5	23.0
July 13.	55.0	49.0	45.0	Aug. 16.	56.0	50.5	41.0	Sept. 19.	39.0	44.5	20.0
July 14.	54.0	49.0	42.0	Aug. 17.	58.0	50.5	45.0	Sept. 20.	39.0	44.0	20.0
July 15.	53.0	49.0	39.0	Aug. 18.	57.0	50.5	47.0	Sept. 21.	38.5	43.5	15.0
July 16.	54.0	49.0	42.0	Aug. 19.	56.0	50.5	44.0	Sept. 22.	38.0	43.0	17.0
July 17.	54.0	48.5	29.0	Aug. 20.	53.0	50.5	45.0	Sept. 23.	38.0	42.5	12.0
July 18.	52.0	48.5	40.0	Aug. 21.	53.5	50.5	36.0	Sept. 24.	37.0	42.5	15.0
July 19.	55.0	48.5	42.0	Aug. 22.	53.0	50.5	38.0	Sept. 25.	37.0	42.5	11.0
July 20.	53.0	48.5	42.0	Aug. 23.	51.0	51.0	26.0	Sept. 26.	35.5	41.5	11.0
July 21.	52.0	48.5	32.0	Aug. 24.	51.0	51.0	32.0	Sept. 27.	32.0	41.0	4.0

KENAI EXPERIMENT STATION.

Day.	6-inch ther- mometer.	24-inch ther- mometer.	Day.	6-inch ther- mometer.	24-inch ther- mometer.	Day.	6-inch ther- mometer.	24-inch ther- mometer.
1902.	° F.	° F.	1903.	° F.	° F.	1903.	° F.	° F.
Sept. 1.	52.5	49.5	May 19.	37.0	.....	June 18.	55.0	38.5
Sept. 2.	51.0	49.5	May 20.	37.0	.....	June 19.	51.0	40.0
Sept. 3.	52.0	49.5	May 21.	36.0	.....	June 20.	50.0	40.5
Sept. 4.	53.0	49.0	May 22.	37.0	.....	June 21.	50.0	41.0
Sept. 5.	53.0	49.0	May 23.	35.0	.....	June 22.	49.5	41.0
Sept. 6.	52.0	49.0	May 24.	37.5	.....	June 23.	52.0	41.5
Sept. 7.	50.5	49.0	May 25.	39.0	.....	June 24.	55.0	42.0
Sept. 8.	50.5	49.0	May 26.	41.0	.....	June 25.	53.5	42.5
Sept. 9.	51.0	48.5	May 27.	39.0	.....	June 26.	52.5	43.0
Sept. 10.	48.5	48.5	May 28.	41.0	.....	June 27.	53.0	43.5
Sept. 11.	49.0	48.0	May 29.	40.0	.....	June 28.	55.0	43.5
Sept. 12.	47.5	48.0	May 30.	42.0	.....	June 29.	53.5	44.0
Sept. 13.	48.0	47.5	May 31.	41.5	.....	June 30.	53.5	44.5
Sept. 14.	48.0	47.5	June 1.	41.0	32.0	July 1.	55.0	44.5
Sept. 15.	46.0	47.0	June 2.	42.5	32.0	July 2.	51.5	45.0
Sept. 16.	47.5	47.0	June 3.	42.5	32.0	July 3.	54.0	45.0
Sept. 17.	49.0	47.0	June 4.	41.0	32.0	July 4.	56.0	45.0
Sept. 18.	47.0	46.5	June 5.	44.0	32.5	July 5.	53.0	45.0
Sept. 19.	46.5	46.5	June 6.	45.0	32.5	July 6.	54.0	45.5
Sept. 20.	47.0	46.5	June 7.	44.0	33.0	July 7.	53.0	46.0
Sept. 21.	47.5	46.5	June 8.	45.0	33.5	July 8.	53.0	46.0
Sept. 22.	48.0	46.5	June 9.	44.5	34.0	July 9.	54.5	46.0
Sept. 23.	46.5	46.5	June 10.	44.0	34.5	July 10.	55.0	46.0
Sept. 24.	44.5	46.0	June 11.	43.0	35.0	July 11.	55.5	46.5
Sept. 25.	42.5	45.5	June 12.	44.0	35.0	July 12.	64.5	46.5
Sept. 26.	40.5	45.0	June 13.	43.5	35.5	July 13.	54.0	46.5
Sept. 27.	42.0	44.5	June 14.	44.5	36.0	July 14.	54.0	47.0
Sept. 28.	43.0	44.0	June 15.	46.0	36.5	July 15.	54.5	47.0
Sept. 29.	44.5	44.0	June 16.	48.0	37.0	July 16.	55.0	47.5
Sept. 30.	45.0	44.0	June 17.	53.5	37.5	July 17.	54.0	47.5

Soil temperatures—Continued.

KENAI EXPERIMENT STATION—Continued.

Day.	6-inch ther- mometer.	24-inch ther- mometer.	Day.	6-inch ther- mometer.	24-inch ther- mometer.	Day.	6-inch ther- mometer.	24-inch ther- mometer.
1903.	° F.	° F.	1903.	° F.	° F.	1903.	° F.	° F.
July 18	53.0	47.5	Aug. 12	56.5	50.5	Sept. 6	52.0	49.5
July 19	55.0	47.5	Aug. 13	58.0	50.5	Sept. 7	52.0	49.5
July 20	55.0	47.5	Aug. 14	58.5	50.5	Sept. 8	52.5	49.5
July 21	55.5	47.5	Aug. 15	59.0	51.0	Sept. 9	52.0	49.0
July 22	55.5	48.0	Aug. 16	61.0	50.0	Sept. 10	52.0	49.0
July 23	55.5	48.0	Aug. 17	58.0	51.5	Sept. 11	50.5	49.0
July 24	59.0	48.0	Aug. 18	57.5	51.5	Sept. 12	50.0	48.5
July 25	58.0	48.5	Aug. 19	57.5	51.5	Sept. 13	50.5	48.5
July 26	55.5	49.0	Aug. 20	57.0	51.5	Sept. 14	52.5	48.5
July 27	52.5	48.5	Aug. 21	57.5	51.5	Sept. 15	53.0	48.5
July 28	56.0	49.0	Aug. 22	57.0	51.5	Sept. 16	51.0	48.5
July 29	56.0	49.5	Aug. 23	58.0	51.5	Sept. 17	50.5	48.5
July 30	57.0	49.5	Aug. 24	56.0	51.5	Sept. 18	50.0	48.5
July 31	56.0	49.5	Aug. 25	56.0	51.5	Sept. 19	49.5	48.5
Aug. 1	54.0	49.5	Aug. 26	55.0	51.5	Sept. 20	48.5	48.5
Aug. 2	54.0	49.5	Aug. 27	55.0	51.5	Sept. 21	49.0	48.0
Aug. 3	57.0	49.5	Aug. 28	55.5	51.0	Sept. 22	48.0	48.0
Aug. 4	55.0	49.5	Aug. 29	55.0	51.0	Sept. 23	46.0	47.5
Aug. 5	56.0	49.5	Aug. 30	53.5	50.5	Sept. 24	45.5	47.0
Aug. 6	56.0	49.5	Aug. 31	54.0	50.5	Sept. 25	46.5	47.0
Aug. 7	58.5	50.0	Sept. 1	54.0	50.0	Sept. 26	45.0	46.5
Aug. 8	56.5	50.0	Sept. 2	52.5	50.0	Sept. 27	43.0	46.0
Aug. 9	57.0	50.0	Sept. 3	53.5	50.0	Sept. 28	41.5	45.5
Aug. 10	57.5	50.0	Sept. 4	52.0	50.0	Sept. 29	42.0	45.0
Aug. 11	57.0	50.5	Sept. 5	51.0	49.5	Sept. 30	40.0	41.5

METEOROLOGICAL REPORTS.

Heretofore we have published the accumulated weather reports each year, but as they are now becoming too voluminous, only the last year's records are submitted herewith. They speak for themselves.

Meteorological observations.

KETCHIKAN. D. S. Whitfield, Observer.

Month.	Temperature.			Total precipi- tation.	Weather conditions (number of days).			
	Maxi- mum.	Mini- mum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	° F.	° F.	° F.	Inches.				
May a	57	41	48.9	2.79	5	2	2	6
June	78	46	57.5	3.31	28	1	1	14
July	69	62	58.6	5.62	25	3	3	9
August	73	64	55.9	22.39	4	15	12	25

KILLSNOO. Joseph Zuboff, Observer.

1902.								
October	57	32	43.5	4.60	-----	5	26	13
November	47	19	32.7	2.75	9	5	16	13
December	41	10	23.7	2.90	10	4	19	13
1903.								
January	41	4	29.5	4.05	3	6	22	20
February	40	8	30.7	2.40	1	9	13	13
March	46	10	29.4	.20	15	7	9	3
April	59	21	38.6	6.15	16	-----	14	4
May	61	31	45.3	2.55	5	2	21	9
June	72	38	53.5	.75	5	16	9	7
July	70	42	55.1	1.15	6	13	12	5
August	72	41	55.8	2.30	9	10	12	9
September	63	35	49.4	3.10	3	9	8	16

a9 days.

Meteorological Observations—Continued.

SITKA. F. E. Rader, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maxi-mum.	Mini-mum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	° F.	° F.	° F.	Inches.				
October.....	59	32	47.2	8.25	2	11	18	19
November.....	50	23	37.3	6.19	13	2	15	14
December.....	46	8	27.4	5.93	6	3	22	14
1903.								
January.....	54	10	33.7	6.61	3	3	25	18
February.....	41	10	33.9	8.68	2	2	21	19
March.....	50	11	34.0	2.57	15	3	13	10
April.....	63	21	39.5	4.25	5	13	12	15
May.....	56	32	43.6	3.65	3	6	22	14
June.....	77	36	52.35	2.87	5	8	11	4
July.....	77	42	55.1	2.85	5	8	13	10
August.....	79	42	57.6	3.9	12	6	18	13
September.....	67	30	51.2	5.80	6	13	11	19

JUNEAU. John McLaughlin, Observer.

1902.								
October.....	65	31	45.5	6.57	3	11	17	15
November.....	46	20	32.4	7.38	10	1	19	12
December.....	40	8	23.5	4.26	9	10	12	9
1903.								
January ^a		5		11.31	5	7	19	
February.....	42	7	31	7.29	10	2	16	13
March.....	47	12	30.8	3.04	13	7	11	8
April.....	58	16	39.6	3.74	8	5	17	11
May.....	60	36	46.77	6.71	11	6	14	19
June ^b	79	39	55.3	1.14	15	5	6	7
July ^a	77	46	56.8	2.36	7	3	9	8

SKAGWAY. H. D. Clark, Observer.

1902.								
October.....	58	25	42.96	1.75	4	15	12	9
November.....	48	4	27.21	1.24	15	7	8	4
December.....	45	— 2	16.36	1.44	12	4	15	5
1903.								
January.....	47	—17	19.29	2.08	7	17	7	5
February.....	44	— 1	27.1	1.44	5	16	7	8
March.....	48	5	29.0	1.43	15	8	8	1
April.....	60	9	39.41	1.48	8	14	8	3
May.....	61	31	48.45	1.10	6	12	13	4
June.....	82	33	57.5	.56	17	7		4
July.....	79	41	58.5	.02	14	2	15	1
August.....	78	39	55.32	2.08	19	2	10	8
September.....	65	32	49.96	1.11	7	11	9	11

ORCA. W. J. Shephard, Observer.

1902.								
September ^c	68	31	47.9	12.71	4	8	2	9
October.....	57	30	41.0	35.56	5	7	19	25
November.....	42	11	30.9	11.10	10	9	11	12
December.....	39	7	23.9	11.42	11	5	12	12
1903.								
January.....	45	11	25.2	16.74	6	9	15	16
February.....	41	20	30.5	16.60	2	8	18	20
March ^d								
April ^d								
May ^d								
June ^d								
July ^c	90	45	58.7	5.81	10	10	1	10
August.....	76	11	57.2	10.75	13	7	11	13
September.....	67	38	52.3	16.67	13	9	8	9

^c 27 days.
^b 26 days.^c Report for 11 days.
^d Not reported.^c Report for 23 days.

Meteorological observations—Continued.

WOOD ISLAND. Rev. Curtis P. Coe, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maxi- mum.	Mini- mum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	° F.	° F.	° F.	Inches.				
January.....	49	5	30.60	3.89	8	2	23	19
February.....	49	27	36.89	6.29	2	1	25	22
March ^a	55	14	34.39	4.33	9	6	16	8
April.....	59	9	37.31	2.66	5	8	17	8
May.....	71	31	47.16	5.55	11	4	15	13
June.....	82	38	59.11	1.55	15	1	14	6
July ^b	82	40	58.89	1.87	9	.....	22	14
August ^a	77	41	56.05	6.15	5	2	24	16
September ^c	72	38	53.28	5.23	6	3	21	16
October ^d	67	27	44.83	3.75	8	3	20	11
November ^e	53	11	34.52	5.00	11	7	9	8
December ^a	43	-12	22.21	4.95	7	3	26	13
1903.								
January.....	42	4	25.27	1.74	13	.....	18	10
February.....	51	.....	29.30	8.10	3	3	22	16
March.....	60	19	37.63	1.39	19	1	11	2
April.....	51	13	37.37	4.61	11	.....	19	14
May.....	61	33	44.06	4.92	2	.....	29	18
June.....	70	36	51.68	7.80	9	2	19	16
July ^e	76	43	55.86	4.38	10	3	18	10
August.....	85	55	58.51	4.79	5	3	23	14

FORT LISCUM. C. J. Bartlett, Observer.

1902.								
October.....	50	18	34.9	18.20	4	5	22	23
November.....	37	0	21.13	6.98	15	5	10	11
December.....	41	-12	14.61	12.74	22	3	6	9
1903.								
January.....	36	-10	14.78	10.62	14	.....	17	16
February.....	39	10	17.64	13.60	8	.....	20	16
March.....	38	22	17.67	4.72	20	.....	11	9
April.....	46	6	16.60	3.87	19	.....	11	8
May.....	68	30	46.25	2.23	20	.....	11	9
June.....	72	32	48.84	3.24	15	.....	15	11
July.....	70	37	51.15	4.29	11	.....	20	17
August.....	68	34	50.38	6.44	15	.....	16	16
September.....	66	24	44.18	8.62	18	.....	12	11

KENAI. H. P. Nielsen, Observer.

1902.								
September.....	62	16	46.23	4.69	5	7	18	21
October.....	54	8	37.5	3.28	6	10	15	12
November.....	42	-26	19.98	2.58	7	9	14	8
December.....	35	-43	18	3.90	18	1	11	6
1903.								
January.....	49	-26	6.4	1.78	9	8	14	8
February.....	42	-46	18.27	5.70	4	3	21	15
March.....	44	-13	18.95	1.27	19	5	6	5
April.....	59	-17	28.21	1.32	17	6	7	4
May.....	64	23	42.55	1.54	9	9	13	5
June.....	87	29	49.95	1.16	6	9	13	8
July.....	74	31	51.9	2.48	12	7	12	11
August.....	75	29	53.8	3.75	10	9	12	15

^a 29 days only.
^b 28 days only.

^c 25 days only.
^d 23 days only.

^e 27 days only.

Meteorological observations—Continued.

TYOONOK. Thomas W. Hammore, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	°F.	°F.	°F.	Inches.				
September.....	66	25	48.25	6.46	4	11	15	16
October.....	58	20	40.45	4.93	6	11	14	15
November.....	39	-13	22.20	.94	12	5	13	5
December.....	34	-21	9.48	1.72	18	3	10	5
1903.								
January.....	38	-12	10.9	1.95	14	12	5	8
February.....	39	-21	19.45	3.91	5	4	19	15
March.....	49	0	21.27	.45	22	3	6	2
April.....	56	-1	32.1	1.01	15	4	11	1
May.....	68	30	44.86	.65	15	1	15	3
June.....	91	34	52.38	1.59	14	4	12	9
July.....	75	39	55.31	2.62	15	3	13	13
August.....	76	39	57.11	5.69	20	1	10	12

COAL HARBOR, UNGA ISLAND. Henry S. Tibbey, Observer.

1902.								
September.....	63	33	48.7	4.98	2	7	21	20
October.....	55	32	44.5	3.49	5	9	17	23
November.....				7.12	4	6	20	26
December.....				1.30	11	7	13	11
1903.								
January.....	40	-10	23.1	3.90	12	5	14	11
February.....	45	-10	29.5	7.32	4	7	17	22
March.....	54	19	35.0	2.90	19	3	9	8
April.....	51	15	33.5	2.31	7	5	18	20
May.....	54	31	40.6	2.79	7	3	21	17
June.....	61	34	46.8	2.05	4	11	15	10
July.....	61	40	50.1	3.66	3	7	21	19
August.....	69	31	51.6	3.64	5	7	19	17
September.....	59	31	48.0	5.29	4	7	19	11

HERENDEEN BAY. George Jamme, jr., Observer.

1902.								
August.....	62	42	54.3					
September.....	62	32	48.9		2	8	18	28

HERENDEEN BAY. Capt. J. Duncan, Observer.

1902.								
October.....	56	23	34.25	5.10	3	3	23	24
November.....	47	12	33.5	6.30	4	2	21	23
December.....	45	-7	20	.89	8		23	
1903.								
January.....	41	-15	16.1	2.35	10		21	10
February.....	44	-17	27.5	6.61	4		21	15
March.....	49	15	31.4	1	8	6	17	10
April.....	45	15	32.3	2.25	1	6	23	16
May.....	53	30	39.6	2.59	2	8	21	21
June.....	65	32	47	1.01	4	9	17	8
July ^a								
August.....	68	38	50.4	2.51		3	28	18

^aFifteen days.^bTemperature not reported.^cTwenty-seven days only.^dNot reported.

Meteorological observations—Continued.

COPPER CENTER, R. Bliz, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maxi- mum.	Mini- mum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	°F.	°F.	°F.	Inches.				
October.....	66	1	34.2	0.72	11	18	21	4
November.....	32	16	15	1.50	17	11	2	1
December.....	31	53	12.1	1	20	8	3	2
1903.								
January.....	37	-60	12.6	.....	11	1	16	.....
February.....	43	-55	7.8	.....	17	4	7	.....
March.....	41	-25	14.8	.2	21	8	2	1
April.....	58	25	24.0	.....	22	7	1	.....
May.....	80	23	47.3	.60	6	16	9	6
June.....	96	30	56.9	1.38	5	18	7	8
July.....	87	29	58.1	.99	6	12	13	5
August.....	85	24	58.3	1.16	11	.....	17	10
September.....	75	8	43.31	1.31	18	.....	12	5

FORT GIBBON, Henry F. Simmons, Observer.

1902.								
October.....	53	-9	27.56	1.79	10	16	6	16
November.....	15	-15	8.5	.31	18	8	4	1
December.....	25	64	19.82	1.36	10	9	8	14
1903.								
January.....	20	-66	23.85	.37	15	7	9	6
February.....	35	68	-4.39	.73	8	7	13	13
March.....	39	27	8.59	1.14	11	4	16	13
April.....	49	-39	14.7	.23	20	5	5	4
May.....	65	13	42.59	.16	19	6	6	3
June.....	88	33	53.8	.38	26	1	3	3
July.....	84	33	57.6	1.76	8	9	14	13
August.....	74	28	56.3	2.31	12	7	12	13

FORT YUKON, Leonidas J. H. Wooden, Observer.

1902.								
May.....		18	.....	.....	.....	.....	.....	6
August.....	81	10	59.4	.74	.....	.....	.....	7
September.....	66	21	41.6	1.88	.....	.....	.....	8
October.....		0	.....	2.37	.....	.....	.....	5
November.....		-51	.....	1.60	.....	.....	.....	8
December.....		-62	.....	.75	.....	.....	.....	.....
1903.								
January.....		-65	.....	.62	.....	.....	.....	6
February.....		-58	.....	1.09	.....	.....	.....	9
April.....		-20	.....	.31	.....	.....	.....	5
May.....		8	.....	.35	.....	.....	.....	2
June.....		36	.....	.77	.....	.....	.....	3

June and July of 1902 not reported. March, 1903, not reported. August, maximum for 16 days. September for 15 days.

FORT EGBERT, C. A. Tunholtz, Observer.

1902.								
October.....	68	8	31.85	.76	9	2	20	9
November.....	20	-52	1.9	.62	16	.....	14	4
December.....	28	-59	-21.37	.51	14	.....	17	4
1903.								
January.....	41	-61	19.07	.58	13	2	16	5
February.....	37	-55	3.04	.81	8	4	16	3
March.....	38	-33	8.85	.54	4	6	21	6
April.....	55	-32	20.91	.12	14	6	10	2
May.....	65	10	40.08	1.38	11	1	19	6

Meteorological observations—Continued.

FORT EGBERT. Capt. John B. Clayton, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maxi- mum.	Mini- mum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1903.	°F.	°F.	°F.	Inches.				
June.....	87	32	63.78	1.57	25		1	4
July.....	82	38	65.9	2.40	12		19	10

TELLER REINDEER STATION. T. L. Brevig, Observer.

1902.								
January.....	36	-41	.....	7	9	3	19	2
February.....	36	-20	5.4	3	13	2	13	2
March.....	20	-28	-17.1	2	26	1	4	2
April.....	40	-29	19.0	4	17	2	11	5
May ^a	59	-20	20.0	.....	9	6	10	0
June ^b	75	31	44.92	.....	16	11	12	0
July.....	76	32	51.0	4.25	11	.....	18	9
August ^c.....	.....	.....	.....	.....	.....	.....	.....	.....
September ^d	60	26	40.31	.75	12	1	11	2
October ^e	47	11	31.96	2.25	.....	2	28	.....

POINT BARROW. H. R. Marsh, Observer.

1902.								
August.....	57	28	37.7	0.48	10	6	15	4
September.....	39	24	36.56	.1	2	7	21	4
October.....	36	5	25.23	1.41	3	6	22	8
November.....	22	-26	2.43	.42	7	4	17	3
December.....	25	-35	13.64	.....	23	.....	8	.....
1903.								
January.....	17	-52	21.78	.20	19	1	11	3

^a May 26 days.^b June 29 days.^c August not reported.^d September 26 days.^e October 30 days.

ANNUAL REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION FOR 1903.

By JARED G. SMITH, *Special Agent in Charge.*

BUILDINGS.

During the fiscal year 1903 the work of construction of new buildings and permanent improvements was continued, it being considered essential to largely increase the equipment of the station in this regard. (Pl. XIV.) A small cottage containing 4 rooms was built on the lower portion of the reservation, and during a portion of the year this building was used as a residence by two of my unmarried assistants. Later, other arrangements having been made, it was transformed into a library and office building, for which purpose it is now being used. A transfer of the office to this site makes it more convenient and accessible from the city. The fencing, commenced during the previous year, was continued, and during the twelve months about one mile of fencing was built. Until this can be continued, so as to inclose all of the land in the station reservation, there is much of it of which no use can be made for experimental work of any character, because of the cattle and horses that run at large. A small structure was erected near the director's residence for the purpose of commencing the study of the growth of plants under cloth. One-thirtieth of an acre was covered with a frame and over this was spread thin muslin, and a beginning was made with Sumatra tobacco, cantaloupes, grapes, and tomatoes under this shelter. Before the close of the year, this preliminary work having been closed, the structure was torn down in order that the ground could be used for other purposes. The water system was extended so that about 4 acres of land on the lower portion of the reservation is provided with underground pipes for irrigation.

APPARATUS.

In addition to the buildings, fencing, etc., the permanent equipment was increased by the purchase of a number of sets of scientific books and periodicals for the library and some apparatus for the entomological laboratory. There being no chemist at the station, nothing was done toward equipping a chemical laboratory, but a commencement was made toward getting together a chemical library. Over 200 volumes were added to the library during the year, mainly along the lines

of chemistry, entomology, and tropical agriculture. The exchange list was largely increased, both from the United States and from foreign countries. We now have all of the standard economic works on American entomology and are adding, as opportunity affords, advancing the library along certain lines. During the coming fiscal year as much money as can be conveniently spent for that purpose will be devoted to filling it with books on all of the lines relating to tropical agriculture, which will be absolutely essential for best work by the members of the staff. Besides the library and apparatus a number of tools required for farm work were purchased, including some corn-cultivating machinery for use in one of the experiments conducted on the island of Maui.

EXPERIMENTS.

The experiments undertaken were, in the main, along the lines begun in the previous year, but, if possible to do so, an attempt will be made to extend the work to embrace other important lines of investigation.

CORN.

As has been previously stated, the most important corn-growing section in the Hawaiian Islands is the Kula district, on the island of Maui. This comprises some 7,000 acres on the leeward slope of Haleakala, at an elevation of between 2,500 and 5,000 feet. The soil ranges in depth from 6 inches to as many feet, and consists of a very fine and powdery loam. This Kula region has been famous for its fertility, the land having been in cultivation for sixty years.

It was in this district that much of the wheat grown for export from the Hawaiian Islands was raised during the time of the early gold excitement in California. This district, in common with many others of the group, is divided mainly into large holdings, but the corn land and the land capable of the cultivation of corn is leased in parcels of small acreage to Portuguese, Japanese, and Chinese tenants. Many of these small farms, if they may be termed such, especially those along the government road which runs from Makawao to Makena, have been in cultivation continuously, in some cases, for forty years. The climatic conditions are such that the best results can not be counted on oftener than three years out of five. Nevertheless the yields have in former years been so heavy that the losses of the bad years were more than made up for by the intervening good seasons, and both the corn crop and the potato crop have yielded large returns. As has been stated before, the land is in itself extremely rich, and its physical characteristics are such that it would stand a good deal of poor cultivation. The texture of the soil is so loose and friable that deep plowing and thorough cultivation would be as easy here as on the black prairie loams of the West. But good cultivation by the tenants of these



HAWAII STATION—VIEW OF STATION, BUILDINGS, AND GROUNDS.

lands has been an exception rather than a rule. The practice has been to plow to the depth of not to exceed 1 to 3 inches and the cultivation has been by hand rather than by horse labor, practically no machinery except garden tools being used. With this extremely shallow cultivation the yields in former years have been surprisingly high, as much as from 50 to 60 bushels of corn per acre, a yield which would be considered above the average in the corn States. The summer of 1902 was a bad season for the corn growers of this district, as was also the preceding year. The yields were uniformly so low that many of the lands were given up and were allowed to go back into the grass. Besides being rather an unfavorable season, the corn was badly affected with an aphid, which increased so greatly in numbers that, early in August, at the time when the corn should have been filling, the leaves of the plants were brown and shriveled as if struck by frost. A demand was made by the residents of this corn-growing section that the station undertake work for the improvement of conditions then existing, and with this end in view a number of visits were made to this district during the year. At the time the work of the corn-plant louse was called to our attention the crop was too badly damaged to do anything of any real value, but a survey was made of the district with a view of undertaking new work during the next growing season. The ravages of this plant louse could not be checked, but advice could be given in regard to fighting this pest should it appear during the next season. To treat a large acreage by the application of insecticides would be impossible; but this, as well as any other insect pest of a similar nature, could in a measure be held in check by improving the condition of the plant itself. Any plant which has an abundance of plant food—in other words, any plant which receives good cultivation—is much better prepared to resist the attacks of insects than a plant which is not in the best condition of development. In other words, the improvement of the crop would be most likely to be brought about by the improvement in the method of cultivation. Instead of plowing the land to a depth of 1 to 3 inches, turn it under to a depth of 6 to 8 inches, and for cultivating by hand substitute cultivation with corn cultivators. Because of the steadily decreasing crops during the past ten years, the tenants have considered it impracticable to spend more money in more thorough cultivation, so that the whole industry of this little region has been on the down grade. Arrangements were made with Mrs. Dora Von Tempsky, of Kula, to cultivate some 10 acres of land, plowing it to a depth of from 6 inches to a foot or as deep as practicable. It was also thought best to introduce new seed. A number of the best varieties of corn from the Middle West and from the New England States were procured.

The practice has been to clear off all of the cornstalks and all of the weeds and grass in the cornfields, pile and burn them previous to

plowing for the new crop. In this way, and also through the washing of the soil, when unprotected by weeds and grass, much of the finest and richest surface soil has been washed off, and there has been considerable loss in soluble plant food. The people in this region are too poor to purchase commercial fertilizers, but it is quite within the means of any of these men to utilize the homemade fertilizers of the farm. To some extent it has been the practice in this district to burn farmyard manure or to throw it into the gulches. Year after year everything in the way of weeds and cornstalks has been destroyed or burned as being something of no value. To improve the condition of the soil, it is advisable to increase the humus content of the soil. As a beginning, and especially as an object lesson, a stalk cutter was purchased in Nebraska, and the standing cornstalks on the 10 acres of land chosen for the experiment were chopped down by this stalk cutter and plowed into the soil, and the weeds and grass on the land were also plowed in. The land was not simply plowed, as has been customary by others, to a depth of 1 to 2 inches, but to a depth of from 6 inches to a foot. During this plowing all of the large stones which had been plowed up were taken from the field. As a matter of course a considerable quantity of subsoil was thrown up, and the presence of this subsoil at the surface would, to a certain extent, decrease the yield of corn during the first year, but it would improve the condition of the soil for the second and succeeding years. On one piece of land, and especially on several washed knolls, a quantity of manure from an old corral was spread over the surface of the land before plowing. In addition to these methods of improving the condition of the soil, and hence the general condition of the plants themselves, a crop of crimson clover seed was sown between the corn rows at the last cultivation just before the crop was laid by. Not only has clover never been planted in these islands, but no crop whatever is ordinarily used on the land where corn is planted to retain the surface soil and prevent washing. On all of these cornfields a good many milch cows and horses are pastured after the crop has been harvested. A crop of clover, grown on the land after the corn is harvested, would not only improve the condition of the soil for succeeding corn crops, but would also supply forage during the cold and usually rainy winter season. About an acre of a small white bean was sown during the winter of 1902 on a part of this experimental cornfield, with a view not only to enriching the soil by turning under the crop, but also to see if an intermediate money crop could not be produced during the time that the ground was idle. This part of the experiment was not very successful, the yield of beans being too small to warrant anyone attempting to grow them for profit, but the vines and stubble were, instead of being burned, turned under and the humus content of the soil increased to that

extent. Not only were a number of improved varieties of seed corn planted, but an experiment was made in method of planting. Instead of dropping the seed by hand, as is customary in this district, a portion of the land was planted with a one-horse planter, and on one portion of the field the seed was dropped in deep furrows instead of being planted on the smooth surface. This experiment is not yet completed; in fact it will be best to continue this experiment through a term of years.

At the end of June of the present fiscal year the corn planted on the land on which the manure had been applied was looking especially fine, and the corn which had been planted in deep furrows in plowed land was also in better condition than that which had been simply planted in surface rows. Two of the varieties, the Leaning and the Boone County White, were making a much more favorable growth than any of the others, or than what may be called the native corn. Reports received since June indicate that these two varieties are particularly adapted to cultivation in the Kula district.

POTATOES.

The potato experiment begun during 1902 was continued. A small quantity of seed of the 4 varieties, which showed a tendency to resist the black rot, was procured from Maine. Unfortunately, the seed was delayed in transit. It did not arrive until fully a month after the time for planting potatoes, and then in such bad condition that only a few tubers of each variety were left to plant. This failure to procure good seed of course rendered it impossible to continue the experiment as planned last year. In the meantime, through correspondence with the Office of Experiment Stations, we had been informed in regard to experiments which were being conducted by the Ohio Experiment Station in the treatment of perhaps this same potato disease. A quantity of seed was purchased in the Honolulu market and the work was continued on the same land in the Kula district, but with a view to finding out whether active measures could not be used in fighting the disease. The potatoes were soaked in a solution of 3 per cent formalin for from twenty minutes to half an hour just before planting. Then the seed was dropped in furrows, covered, and then the whole furrow was sprayed with the 3 per cent formalin solution, as Professor Selby, of the Ohio Experiment Station, had stated in his report in regard to a similar disease that this treatment, both of the seed and of the soil, with formalin in a measure insures the crop against the destruction by the very serious *fusarium* fungus. The formalin costs about 25 cents per pound in the local market, and about 40 pounds were used in treating the seed potatoes and in spraying the furrows where the potatoes were planted on 1 acre of land. The cost of application was not excessive, and if formalin could be procured at cheaper

prices, as it undoubtedly could be in larger quantities, an acre of potatoes should be treated at an expense of less than \$10. The plants on this treated plat were comparatively free from the "quick rot," although some individual plants throughout the patch were affected by it. Indications at the close of the year were that this experimental plat would yield a fairly good crop of potatoes. While not wishing to definitely recommend this method of treating potatoes to prevent the "quick rot," it is believed from the results obtained from one year's work that this method is not only practicable, but economical as well. In the case of a fungus of this kind, which lives entirely in the soil and which remains in living condition in the soil for certainly two or three years, the only other method of fighting the fungus which causes the disease would be to plant some other crop which it does not destroy. We can at this time recommend no other crop to substitute for potatoes, and hence believe that the station has scored a decided success as a result of this experimental treatment of the land itself to destroy the fungus. It is not recommended as an invariable method, but the indications are that the treatment either of the seed or of the soil, or of both the seed and soil, with a comparatively strong solution of formalin, a powerful disinfectant and germicide, will give some measure of insurance against total loss of the potato crop from this "quick-rot" disease.

TARO.

The taro experiment begun in the previous year was continued. The first trial crop was harvested in September, 1902, and the plants were found to be almost entirely free from the root-rot disease. The yield on the trial plat was much greater than on any of the other taro patches which had not received treatment to prevent root rot. A new crop was planted on the same land, in October, 1902. The hules being selected from plants which were not diseased, no further application of lime or fertilizers was made. The effect during the present growing season of the fertilizers and lime applied last year has been more marked than during the previous season. While the crop has not been harvested, the general appearance of the plants indicates that they are much healthier than any of the untreated surrounding patches. In the absence of laboratory facilities to study the nature of the disease and determine whether the fungus is infectious, as has been supposed, arrangements were made with Doctor Pierce of the Pacific coast pathological laboratory, of the Bureau of Plant Industry, at Santa Ana, Cal., to study the etiology of the disease. A considerable quantity of diseased taro was sent to Doctor Pierce, who is now carrying on an investigation in regard to the nature of the fungus. The second taro disease, of apparently bacterial origin, has proven very serious around Honolulu during the past season. A microscopic examination of

infected roots show the fibro-vascular bundles to be completely clogged with great masses of bacteria. However, in the case of this second root rot, which may be called a brown core rot, no experiments or investigations have been made, because of a lack of proper laboratory equipment.

TOMATOES.

In February, 1903, the first experiment with tomatoes was undertaken. One hundred and forty-five varieties were secured from dealers in the United States, Australia, and Europe. The idea of the experiment was in the main to determine what are the best commercial varieties for this climate. The tomato plant grows here as a perennial, but in the case of almost all of the varieties there is a rapid deterioration in the quality of the fruit, especially when seed from improved horticultural forms, locally grown, are replanted year after year. While tomatoes are continuously on sale in our markets the quality is not of the best, and the statement is often made that good tomatoes can not be grown here. The plan of the experiment was as follows:

Three methods of planting were tried, in flats or boxes. The first planting was in large flats under cloth. After two weeks the seedlings were transplanted to small flats under cloth, then hardened off in the open air preparatory to finally transplanting them to the field. The second method was to start the seed in small flats under cloth and harden them off in the flats by direct exposure to air and sunshine. The third plan was to start the seed in flats in the open air, with only partial protection from the wind. In the field three methods of planting were used. The vines were placed in the furrow, on the ridge, and on the level surface of the ground. Thirty vines were used of each variety, ten vines in a row. Two vines in each row were fertilized with nitrate of soda and Thomas slag. One vine in each row was rigorously pruned back. The blossoms were pulled off from two vines in each row, and the plant was not permitted to produce any fruit until it had made a strong growth. Two forms of trellis were used to keep the plants up off the ground. Some plants were simply tied to a stake, and in the case of others a lath trellis was placed along both sides of the row to keep the lower branches off the ground. The chief difficulty in growing tomatoes here is to get them of good size and color. There is a fruit fly which stings the tomato and deposits its eggs in the fruit, and these develop into maggots which utterly ruin the fruit. Observations were also made in regard to the effect of different methods of treatment on this fruit fly. Notice was taken in regard to the shape, thickness of skin, size, sweetness, keeping quality, etc., and the extent to which the tomatoes rot on the vines. Some varieties show quite a marked resistance, both to the prevalent tomato rot and the attacks of the tomato fly.

An analysis was made of the soil on which these tomatoes were grown. It contained potash, 0.58 per cent; lime, 1 per cent; magnesium, 4.55 per cent; phosphoric acid, 0.75 per cent, and nitrogen, 0.38 per cent. It will thus be seen that this soil is exceptionally rich. The only fertilizers required were lime to balance the magnesium and a general fertilizer to replace the elements removed. The high percentage of magnesium in this soil is unusual, although it bears the relation to lime which many of the Hawaiian soils do. The tomatoes on this plat grew too rankly to produce the best results. Many of the varieties showed a tendency to keep on producing vine indefinitely without flowering or setting fruit. This experiment was not carried through to a conclusion because Mr. T. F. Sedgwick, agriculturist of the station, resigned before the completion of the season's work and no appointment has as yet been made to fill his place. Nevertheless, many facts in regard to the cultivation of this crop have been determined, and the results will be published some time during the next fiscal year.

FORAGE PLANTS.

The dairying and grazing industry is second in importance to sugar in Hawaii. Upward of 25,000 head of cattle are raised on the 70 or more ranches which comprise fully four-fifths of the total area of the islands. The number of dairy cattle has not been determined, but there are between 25 and 30 dairies in the vicinity of Honolulu, and a large number of the stock ranches have dairies for the production of cream or butter for supplying the local trade on this and other islands. The forage problem is, as may be readily seen, one of the most important lines of investigation. Some work has been done during the past year in the way of preliminary survey of the field. A number of ranches have been visited on Oahu, Kauai, Molokai, Maui, and Hawaii. The special agent in charge of this station was made an honorary member of the Hawaiian Live Stock Association at its annual meeting in Honolulu, November, 1902. It is the aim of the station to undertake, as soon as practicable, experiments along the line of animal industry. The original land divisions throughout the Territory of Hawaii extended in narrow wedges from the mountain to the sea. In the early days, before the settlement of these islands by white men, the land belonged to the king and was by him parceled out to the chiefs. The people owned no land. The idea was to give to every chief a patch of land which should contain mountain land for supplying timber and fiber plants, valley land for taro and food plants, and a strip of sea beach for the fisheries. These original land divisions have been perpetuated so that practically all of the ranches and estates, at least the original ones, are in the form of long narrow strips or wedges, extending from a broad fringe along the seacoast, in a nar-

row strip, back along some valley, to where it narrows to its source in the mountain range. Because of this original method of dividing the land, most of the ranges contain mountain pastures, where the vegetation is rank and where rain falls in many cases almost continuously throughout the year; and dry and almost rainless belts, with scanty vegetation along the coast. The middle ranges, between 2,000 and 5,000 feet elevation, are usually the best. In studying the plant growth of these island ranges the most apparent fact is that there are so few species of grass. Two introduced forms almost completely occupy the land. The Manienie or Bermuda grass of the southern United States has overrun the land from the seacoast to an elevation of 4,000 feet. Above this altitude the Hilo grass, *Paspalum conjugatum*, one of the water grasses, occupies the land almost to the exclusion of other species. These two foreign grasses have almost entirely run out the native grass flora, and on some of the richer and more open ranges one may ride all day without seeing any other grass which constitutes any considerable proportion of the feed. Again there are districts, especially along the leeward coasts of the different islands, where the rainfall is so slight that none of the turf-forming grass can grow. There are many examples of such lands practically without vegetation, except after the winter rains. Practically, the only rains which may be depended upon are the Kona or southerly storms, during the winter season. The rainfall in some of these districts, especially to the leeward of the three high mountain peaks, Haliakala, Mauna Loa, and Mauna Kea, averages less than 10 inches per annum, with occasional seasons when no rain falls at all. From such practically rainless regions there is every gradation of rainfall up to 300 inches per annum, and here, as in all other countries, the amount of rainfall governs the amount and quality of the vegetation. In the early days one of the native grasses, known as Pili (*Heteropogon contortus*), a species which is also common in the southwestern United States, was abundant on the leeward coasts at an elevation of from 200 to 1,000 feet above sea level. However, overstocking has almost entirely destroyed this grass.

Here, as in the Rocky Mountain region, the upper mountain pastures, with their luxuriant forage, are very satisfactory for raising young stock, but to fatten cattle for the market they must be driven down to the pastures at a lower elevation. The greatest number of species of plants which are eaten by stock are found at the higher elevations. The fattening pastures contain principally the one species of grass only, the Manienie. One of the chief problems is to introduce variety on this dry-land pasture by the introduction of grass and forage plants from other semiarid regions. A cooperative experiment was arranged with Prof. J. W. Spillman, in charge of the grass and forage plant investigations of the U. S. Department of Agriculture.

Professor Spillman supplied the station with a considerable quantity of seed of about a dozen of the best grasses of the western plains. The seeds were sown on the ranch of the American Sugar Company, on western Molokai. Because of the delay in the transportation of these seeds, they did not reach the islands in good time to secure the best results. For that reason only a portion of the seed was sown. The entire west end of Molokai is extremely dry. The land is gently rolling and in the main without deep ravines or gulches. The highest point on this part of the island is about 2,000 feet. There is an entire lack of springs or running streams. Nevertheless, on this portion of the island about 5,000 sheep and several thousand head of cattle are ranged throughout the year. The soil is extremely fertile. The vegetation is quite scanty, except for a few weeks in early spring, after the winter rains have germinated the seeds of the annual grasses and weeds. The best of the pasturage does not last very long. This land was chosen as being about the best on which to try an experiment with the introduction of dry-land grasses from other countries. The land chosen for the experiment was harrowed with a straight-toothed harrow, and the seed sown directly afterwards. This was done after one of the late rains of the spring of 1903, but there being no heavy rain subsequent to this time the results have not been very satisfactory. However, a start has been made and a good many plants of several of these new grasses have been obtained. These will undoubtedly in time produce seed and serve as a center for the distribution of seeds over the rest of the range. Because of the lateness of the season only part of the seed received from Washington was used, and the balance will be sown about the 1st of October during the coming year, as from that time on the regular rains may be expected. Circular letters were sent to all the members of the Stockman's Association, requesting them to send in to the station samples of the native grasses and forage plants for determination. It is intended to publish a list of the native and introduced forage plants of the islands as soon as sufficient data in regard to their existence or cultivation throughout the islands are secured. Practically all of the beef sold in the local markets is from animals which have been fattened on the open range. Very little has been done in the way of feeding stock on alfalfa, corn, etc., except on one of the ranches of Kauai, where the cattle are fattened on the waste from a starch manufactory. Some experiments have been made with alfalfa. It grows very well from the sea level up to 2,500 to 3,000 feet elevation. Most of the alfalfa grown is irrigated, but there have been several very successful experiments on a small scale in growing this forage crop without irrigation, especially at a higher elevation where the rainfall is more abundant. Plans are being made to undertake work along the lines of the economical fattening of cattle for market.

DAIRYING.

Much work is to be done in investigations along the line of dairying, especially in the compounding of rations. Sorghum and Johnson grass, known here as evergreen millet, are practically the only forage plants cultivated for feeding dairy cattle. The required nitrogenous feeds are supplied by bran, middlings, and other milled feeds imported from California. Again, while there are many dairies which have full-blooded and grade Jersey, Holstein, and other milk breeds of cattle, certainly the majority of the milch cows on the islands are scrub stock. A cooperative experiment will be undertaken with one of the dairies in the vicinity of Honolulu to work out some of the problems in connection with this industry. Much valuable work in the cultivation of forage plants new on the islands is being carried on by the agricultural department of the Kamehameha Boys' School. Prof. F. G. Krause, who is in charge of this work, has presented a number of papers at the farmers' institute, giving the results of his investigations. Some of these papers will shortly be published for general distribution, as the information contained in them is equally valuable for all of the islands.

ANIMAL DISEASES.

According to the report of the president of the board of health of Hawaii for 1902, 990 cattle, out of a total of 3,376 slaughtered for the Honolulu market during the six months ended December 31, 1902, were infected with liver fluke. Two hundred and forty-seven, out of a total of 487 calves examined during the same period, also showed infection. The liver fluke is an internal parasite which exists for only a portion of its life cycle in the bodies of warm-blooded animals. In the early stage of its development it is parasitic within the bodies of certain fresh-water snails. It secures entrance to the bodies of cattle in the drinking water or through the cattle eating the succulent grasses growing around stagnant water holes, on which the snail also feeds. During the stage of the existence of the fluke, when it is parasitic within the body of the snail, it is extremely minute, but when it enters the body of the animal and finds final lodgment in the ducts of the liver it grows into a flat, worm-like body, often 3 inches or more in length. Its presence in the liver of the infected animal, especially when it exists in any considerable number, often causes the death of the animal. An epidemic of losses from this source was reported to the station from the windward side of the island of Oahu. The cattle principally affected were young cows from 2 to 3 years old. An animal which is infested with liver fluke becomes extremely emaciated, and can be distinguished at a distance in the pastures because of its standing alone, with head up, and apparently without inclination to eat

or move. Death usually occurs through effusion of the blood serum into the abdominal and lung cavities. This is followed by the formation of dropsical swellings along the under side of the body, extending forward to the neck and throat, at which time the animal usually dies from suffocation. A number of post-mortems were made and notes were taken in regard to the symptoms. In every case where the carcasses of cattle which had died were examined, enormous numbers of the flukeworm were found in the liver and bile ducts and in the gall bladder. The blood becomes almost entirely free from red corpuscles, and the animal dies because of the dropsical condition which ensues. As the liver fluke, to complete its round of existence, must pass a portion of its life in the body of the snail, the drainage of marshes and water holes, where the rank vegetation harbors the snails, will prevent the infection of stock. Liver fluke is worse in the windward districts, where the rainfall is high, and also in the upper mountain pastures. Cattle which are confined throughout their life to pastures on the drier portions of the islands are seldom infected with liver fluke. The remedy in all cases is to see that an abundance of fresh water is supplied the cattle so that they will not be under the necessity to frequent the stagnant water holes which supply the source of infection.

TOBACCO.

A small amount of Sumatra tobacco was grown under cloth at the experiment station during the spring of 1903. While the crop was not of the best, because of the soil not being suited to this type of tobacco, the results obtained were so promising that a more extended experiment will be conducted during the next year. Up to this time the Hawaiian Islands have been almost absolutely dependent upon a single crop, the cultivation of sugar cane. A number of causes have contributed to the decrease in the amount of profits from sugar. Because of this, and also because of the necessity of having more than one industry on a paying basis in this country, it has been considered advisable to do all in our power to further the establishment of new agricultural industries. A cursory examination of the islands, and especially of certain districts on Maui and Hawaii, lead me to believe that there are considerable bodies of land well adapted to the cultivation of tobacco. A more extended survey of this district will be made during the next fiscal year, and, if possible, a cooperative experiment in tobacco culture will be arranged under the direction of the tobacco experts of the Bureau of Soils.

VANILLA.

The vanilla bean is a cured fruit of the vine belonging to the orchid family. This plant is a native of Mexico, and the world supply of vanilla comes from Mexico and from the tropical and subtropical

islands in the Pacific and Indian oceans, from Madagascar to Tahiti. It has long been in cultivation in Hawaii, but, except on one plantation on the island of Hawaii, only as an ornamental in house yards. It seems to be extremely well adapted to cultivation at the lower elevations, below 1,500 feet, especially on the leeward side of the islands. The principal requisites are a light soil, porous subsoil, moist atmosphere, and protection from strong wind. The flowers require hand pollination; otherwise they will not produce fruit. An experiment in curing and fermenting the vanilla pods to produce the commercial vanilla was made at the station in the early months of 1903. Pods for this purpose were supplied by Hon. S. M. Damon, of Moanalua, one of the suburbs of Honolulu. As a result of this experiment in the fermentation of the crop, and also because the vanilla plant grows so widely and so well from one end of the group to the other, and also because the plants now growing here do not seem to be infected with any of the serious diseases which affect this crop in other countries, the outlook for the cultivation of vanilla on a somewhat extended scale is very bright. The prime requisites to make the cultivation of this crop a success are the selection of a suitable location at a low elevation, where there is protection from the full sweep of the trade winds. Constant and careful attention to every detail of cultivation of the plants, the pollination of the flowers, and the fermentation of the pods to produce a select finished product ready for the market is of even greater importance. The sole difference between a crop of vanilla worth \$1 a pound and one worth from \$10 to \$15 is the care given to the crop from the time the cuttings are planted until the finished product is marketed.

SISAL.

In 1893 the Hawaiian commissioner of agriculture and forestry secured 20,000 sisal plants, which were carefully set out at that time in a large number of localities throughout the islands. This introduction, and especially the wide dissemination of the plants after they reached the islands, proved to be of great value. A few years after this original introduction of sisal a plantation for the cultivation of this crop was formed on the island of Oahu. The sisal plant grows as well here as anywhere else in the world. It is thus far entirely free from any serious insect or fungus disease. The quality of the fiber produced is exceptionally good, bringing almost as high a price in the markets of the United States as the best fiber imported from Yucatan. This crop is one which may be cultivated advantageously on lands which are extremely dry, although it shows a surprising adaptation to districts where the rainfall is 100 or more inches per annum. Nevertheless, the best fiber is produced where the plants grow within a few miles of the Kona coasts. Coral soils have been considered the best for this

crop, probably because the whole peninsula of Yucatan, where sisal is the main crop, is of coral formation. In the Hawaiian Islands sisal seems to do just as well, and the quality of the fiber is certainly not inferior, whether it grows on coral flats along the seacoast or on volcano formations where the soils are deficient in lime. The leeward or Kona districts of the Hawaiian Islands are naturally adapted to the cultivation of this important fiber plant. During the past year a large number of new plantations have been started, and while there is at present only one plantation of some 600 acres which is marketing sisal fiber, the next two or three years will see a very considerable increase in the quantity of fiber exported.

PEPPERS.

Two species of pepper plants, *Capsicum annuum* and *C. frutescens*, are widely scattered in a semiwild condition throughout the islands. Both species were undoubtedly introduced from Mexico or South America, and soon found ready acceptance by the native population. The original cultivated forms have been grown so many years without cultivation that they have reverted to the original species. Instead of being annual, this species is here truly perennial. In almost any situation in which the seed falls the plants which spring up yield enormous quantities of fruit. In consideration of the fact that large quantities of dried peppers are imported annually into the United States from foreign countries, the question of cultivating this crop here has often been considered. Within the last twelve months two small plantations have been established for growing this crop. A quantity of the fruit was dried at the experiment station and samples were sent to some of the leading dealers in condiments in the United States. A number of them replied to the effect that the samples sent were of good commercial quality and several offers were made, provided a sufficient amount of the dried peppers could be gotten together to pay for shipping them.

This plant grows like a weed at all of the lower elevations of the islands, and while the profits from the cultivation of this crop may not be comparable to those of coffee, sugar, vanilla, or sisal, the prices secured for the samples which have been sent to the eastern markets indicate the possibility of inaugurating an industry which will yield a very fair margin of profit. Practically the only labor in connection with growing peppers is that of picking them. The method of curing is simply to dry the pods in the sun and to protect them from rain and moisture during the curing process.

CASTOR BEANS.

The castor-bean plant, so well known as an annual ornamental in back yards and gardens throughout the United States, is perennial in Hawaii. It is not known what the extreme life of this tree is in the

Tropics. There are many specimens all through these islands at elevations from seacoast to 3,000 feet which have attained the height of 30 feet or more, with a trunk diameter of sometimes more than 20 inches. It is certain that its introduction into the islands dates back almost to the time of the arrival of the first missionaries. Considerable experimenting has been done with this crop for the production of the seeds both for export and for the local manufacture of the oil. There are already in operation two plantations which total an area of upward of 100 acres, and within the last six months of the fiscal year these plantings have been very largely increased and many plantations on other islands are engaging in a small way in the cultivation of this crop, with a view to increasing their acreage should the present favorable prices for the beans maintain. There is a ready market for the castor beans in Honolulu, or they may be packed and shipped to the San Francisco or Eastern markets. The crop practically requires no manipulation to produce a finished product, differing in this regard from most tropical products which require various processes of fermentation. The method of planting differs somewhat from that in vogue in other countries where the castor bean grows. The seed is planted where it is to remain on land which has been thoroughly and deeply plowed. The rows are made from 20 to 24 feet apart and the castor-bean trees are allowed to grow 15 feet apart in the rows. As soon as the plants are 2 feet high the terminal bud is nipped off, forcing the production of lateral shoots. These in turn are nipped to compel the tree to branch as much as possible. By this method of treatment a very broadly pyramidal growth is produced, with very much greater bearing surface than if the tree were permitted to establish an upright form. Another advantage of this style of pruning is that the clusters of seed pods are kept within easy reach of the laborer who picks them. The ground between the rows is kept in a good state of cultivation. For the first year at least, or until the lateral branches of the castor-bean plants have extended so as to fill the rows, an intermediate crop, such as sweet potatoes or corn, may be cultivated between the rows. The average yield, judging from those plantations which are now in bearing, ranges from 2,500 to 3,000 pounds of seed per acre per annum. The drawbacks connected with the cultivation of this crop are chiefly the fact that there is no general harvest season, but the seed must be picked at frequent intervals throughout the year. On a small plantation this item of expense would be very serious, but on plantations of any considerable size it would not have to be considered. The castor bean is a crop which at the present time has very few enemies in this country. The plant grows wild from sea elevation to the elevation of 3,000 feet or more, and the best oil-bearing varieties thrive equally as well as the wild forms. It is a crop which seems to be well suited to small landholders.

PINEAPPLES.

There are two large pineapple canneries in successful operation on the island of Oahu. Pineapples grow very thriftily at middle elevations on all of the islands, especially from 1,000 feet upward. Experiments in the cultivation of this crop have been carried on for fully twenty years. Practically all of the known varieties have been imported from all parts of the world where this fruit is grown. As a result of these experiments, carried on by private individuals, it has been found that the Smooth Cayenne variety is the best adapted to Hawaiian conditions.

The fruit attains a degree of excellence not surpassed by any other crop of subtropical fruit. It is said that previous to the annexation of the Hawaiian Islands, canned pineapples imported into the United States from here were made to pay a duty as fruit preserved in sugar, although, as a matter of fact, no sugar was used in the canning process, the fruit simply being preserved in its own juices. The Hawaiian canned pineapples are superior in quality to any others now placed on the American market, because they are allowed to ripen and attain their fullest development in the field. They compete in the markets with similar fruit which has been shipped from the West Indies or Mexico. Pineapples which are shipped long distances must be harvested before they are completely ripe, and hence none of the same class of goods put up for the Eastern markets can in any way compare in quality or flavor with the Hawaiian pines which are not placed in cans until fully and completely ripe. The prices obtained by the local packers for their product are much in excess of prices obtained by the canneries anywhere on the mainland. The demand for our product has been thus far much greater than the possible supply. The pines have not been affected by any serious disease. They are also comparatively free from insect injury, the only pests infesting the plants being mealy bugs and scale insects, and these in too small numbers to cause any serious damage. The soils devoted to pineapple cultivation are at an elevation of from 1,000 to 2,000 feet. The mean summer temperatures of this pineapple belt range from 5 to 10 degrees lower than temperatures in the vicinity of Honolulu or at sea level. The soils are mostly virgin, never having been used for any other crop. Being somewhat acid, the soils improve with cultivation and give better results the fourth and fifth year after setting out the plantation than the second year, when the first crop comes into bearing. There are many thousand acres of land suited to the cultivation of pineapples, and the industry is capable of very great expansion. As long as the Hawaiian growers maintain the high standard of excellence now existing, there will be an almost unlimited market. There is now a very considerable trade in the shipment of the fresh pines to the markets of the Pacific coast, an industry which is also capable of considerable extension. (Pl. XV, fig. 1.)

COTTON.

The ruling high prices for cotton during the last twelve months have caused many inquiries in regard to the possibility of cultivating this crop in these islands. A considerable amount of Sea-island cotton was grown here during the period from 1860 to 1870. From the latter date there was a marked falling off in acreage and before the end of the next decade the industry was entirely abandoned. There are many cotton plants grown mainly for ornament in yards on all of the islands. The plant shows a tendency to live almost indefinitely, there being many individual plants in the city of Honolulu which are known to be from 15 to 20 years old. There would be no difficulty whatever about growing this crop on a commercial scale in these islands, as there are thousands of acres of land not adapted to sugar cane which could be, at very little cost, converted into cotton fields. Cotton is not a crop which brings very large returns per acre, but it has this in its favor that it is a cash crop. Occasional experiments have been made in the cultivation of this crop. The quality of the fiber and the yield compare very favorably with the average results throughout the Southern States. However, there are no cotton gins, so that there would be no local market. A factor which might be taken into consideration in an attempt to establish the cultivation of cotton in these islands would be the proximity to the Japanese and Chinese markets. If this crop is ever grown on an extensive scale, the prices obtained for the fiber should be higher than the ruling prices in the South by the amount of difference in freight between Galveston and New Orleans and the Pacific coast. The average steamship passage from Honolulu to Japanese ports is from nine to ten days, and freight rates of cotton from here to Japan should be correspondingly much cheaper than from Gulf of Mexico ports. Provided cotton can be grown here for export to the Orient, the average of prices received by the producer should be enough higher than the average prices in New Orleans to return a very fair margin of profit to the Hawaiian grower. This station has grown several of the best varieties of cotton. Other experiments, on which more careful notes will be taken in regard to yield and quality of product, will be undertaken should there be a demand for information in regard to the cultivation of this crop.

SUGAR CANE.

The cultivation of sugar cane has for thirty years been the dominant industry in the Hawaiian Islands. The land at present under cultivation in this crop constitutes the coastal plains and a belt of land extending backward from the seacoast a distance of from 3 to 10 miles. The location of the plantations has been governed in the past largely by the available supply of water, either for irrigation or, on those plantations where irrigation is not required, for fluming cane to

the mills. The water supply has been developed remarkably within the last five years, over and above what was considered to be an available limit previous to that time. As a result, either by the discovery of new underground sources of water supply or by utilizing, by means of engineering enterprise, supplies of water previously considered inaccessible, it has been possible to greatly extend the area devoted to the cultivation of this crop. At the time of the passage of the reciprocity treaty the Hawaiian minister at Washington stated that the possible yield of sugar would never exceed 100,000 tons. At the time of the revolution, ten years ago, the advocates of annexation advanced the belief that the annual yield of cane sugar would never exceed 250,000 tons. The development of new sources of water supply and the conservation or improvement of existing sources of water have so changed the situation that, at the present time, no one can properly set a limit upon the amount of land available for the cultivation of sugar cane. The limitations are no longer those of available land and available water, but only such as are marked by the ability to obtain working capital and labor. The climate is ideal for the growth of the sugar-cane plant. The soils, naturally fertile, are capable of quick response to the application of fertilizers and modern methods of cultivation. The fact that the islands are surrounded in every direction by 2,000 miles or more of ocean has worked to prevent the introduction into these islands of the numerous fungus diseases and insect pests which have so seriously affected the cultivation of sugar cane in the continental countries.

As before stated, practically the only limitations to prevent the indefinite expansion of the area cultivated in sugar cane in the Hawaiian Islands is the capacity to obtain capital for investment and the possibility of obtaining the necessary labor. Until the present time all of the cane grown in Hawaii has been cultivated under the plantation system. A large majority of the total population of these islands consists of Japanese and Chinese coolies, imported with the sole view of supplying the labor necessary to the cultivation of sugar cane. The existence in an American community of over 150,000 souls of so large an alien population, consisting of men who understand neither the language, laws, customs, nor the American ideals of government, a class of men who come to this country not to become citizens, but only as a temporary expedient and who expect to return to their native lands as soon as they have obtained what is to them a competency, is certainly in many respects unfortunate.

The statement is often made that a white man can not endure labor in a cane field. This, we believe, is a misstatement of the case. There is nothing in the climate to prevent a man working out of doors every day in the year. The "native sons" of Hawaii are as vigorous a race as any produced in any colder climate. The work in the cane fields is



FIG. 1.—HAWAII STATION—PINEAPPLE PLANTATION.



FIG. 2.—HAWAII STATION—A COFFEE MILL.

not more difficult than that in the harvest fields or in hundreds of occupations which require manual toil in other lands. A successful beginning in the cultivation of sugar cane by white farmers, who own and cultivate their own land, has been made in at least two localities in these islands.

In the Olaa district on the island of Hawaii there are between 60 and 70 independent landowners who are growing cane which they sell to one of the near-by plantations. A part of this number employ no Asiatic labor whatever, they and the members of their families performing all the necessary labor. Cane is being grown by some of the members of the Wahiawa colony on the island of Oahu. It has been proved at least in these two instances that the white man can perform all of the work required in the cultivation of cane at a profit to himself in some cases far above the average received from the cultivation of any agricultural crop on the mainland of the United States.

The successful beginnings made in these two instances will undoubtedly grow to greater proportions. Such a change must of necessity be gradual. The entering wedge must be the establishment of colonies, the members of which can supply to one another that degree of social intercourse which is requisite in any American community. The prevailing conditions are such that individual farmers scattered here and there over the Territory would probably not succeed, but with colonies of sufficient numbers, so that there can be at once established the schools and churches and social organizations to which our people are accustomed, they would thrive and prosper as well in these islands of the Pacific as in any of the mainland States or Territories.

COFFEE.

As stated in my previous annual reports, there is a very large area of land in this Territory which might be devoted to this crop. At a moderate estimate there are 350,000 acres of mountainous land between an elevation of 2,000 and 5,000 feet on which coffee would thrive. The quantity of Hawaiian-grown product now exported from the Territory amounts to about 1,200 tons, worth \$250,000. In the period from 1890 to 1897 the coffee industry received great impetus in these islands because of the high price of this product. Fully 10,000 acres were planted in coffee during that time, and much land was undoubtedly set out in coffee orchards which proved to be not well adapted to the crop. Nevertheless, in certain districts, especially the Hamakua and Kona districts on the island of Hawaii, and in the Waimanalo district on Oahu, the trees have reached a very thrifty stage of development. As a result of the rapid fall of prices in the years succeeding 1896, many of those who had planted extensive areas of coffee with every expectation of at once acquiring a fortune were forced to abandon their plantations as unprofitable. The fact that the coffee industry

was established during a boom has worked against the success of the industry. At the present time a far greater area of coffee is in bearing than there ever was during the palmiest days of the coffee excitement in Kona and Oloa. Furthermore, notwithstanding the remarkable fall in prices, there are still a number of plantations which are making money out of the coffee business. One of the most serious mistakes made at the time of the attempt to establish this industry was one that has been made in almost every new irrigation district of the Pacific coast. Instead of getting in a class of men who had previously made their living from some form of agriculture or horticulture, literature was circulated all over the world that created the impression that here was a golden opportunity where a man with no knowledge of agriculture whatever could make a fortune simply by planting his trees and letting them grow. Agriculture in subtropical regions has just as many drawbacks as in the temperate zone. Skill and a certain amount of knowledge in regard to the growth of plants, methods of cultivation, pruning, the use of fertilizers, and the treatment of the soils, are equally as valuable attributes of the planter in the Tropics as elsewhere. The boom period of the coffee industry in Hawaii is past. The remarkable thrift and vigor of the coffee trees, the enormous crops of berries, yielding coffee of a high quality, indicate that if the cultivation is pursued under business methods as much profit can be made with this crop here as in any other land. The men who are still succeeding in coffee are not only good farmers but business men as well. There is probably no occupation in which the union of these qualities of knowledge of agriculture and of business methods is more necessary than in the management of any kind of a plantation in the Tropics. While it is the oft-expressed opinion of a great many people that coffee can not be grown at a profit in these islands as long as the product sells for less than 12 cents a pound, nevertheless there are a number of planters who realize a fair rate of interest upon their investment when at least a portion of their crop is marketed at as low as $6\frac{1}{2}$ to 7 cents per pound. (Pl. XV, fig. 2.) The hope for the rehabilitation of the coffee industry lies not so much in securing a bounty as in creating for our really very superior product an individual market in the United States. If the Hawaiian coffees can be marketed as Hawaiian coffee, without blending or mixing them with the inferior grades of Central American or Brazilian coffee, it will not be very long before the superiority of our product will create a market for every ton which the islands can produce. Those of our planters who have been most successful have applied to the cultivation of this crop the same care and knowledge of conditions that the sugar planters have applied to the cultivation of sugar cane. The planters have evolved a method of cultivation entirely suited to local

conditions and also entirely unlike the methods pursued in the Central or South American coffee-producing countries. The greatest increase in the rate of income from a given area of coffee will come from improved methods of cultivation and from the use of high-grade fertilizers rather than through an effort to bid down to a still lower level the monthly wages of the laboring class. In other words, cheap labor is not the greatest necessity. There are half a dozen plantations on the island of Hawaii where the yield of coffee has exceeded 2,000 pounds per acre, equal to ten times the average yield per acre in Brazil.

The coffee belt on all of the islands is a region where the climate is almost unexcelled. Although this Territory lies within the Tropics and has advantages which such a location secures, through perpetual absence of severe winter cold, the mean temperature is about 10 degrees lower than that of any other group of islands within equal distance from the equator. The unbroken sweep of ocean to the northward and the trade winds which prevail ten months in every year create conditions not to be found anywhere else in the Tropical Zone. The daily temperatures throughout the year, from sea level to an elevation of 5,000 feet, seldom range below 50° or above 85° F. The climate of the whole group is very equable. Violent storms or tornadoes, such as sweep the West Indies and devastate the mainland of the United States, are here absolutely unknown. If the coffee industry can again be placed upon a suitable basis, and it can be if the people of the mainland of the United States will insist on having Kona and Hamakua coffees supplied them, the question of the introduction of the American farming population in these islands will be answered. Coffee is at present sold in the United States very much according to reputation and fashion. Far more attention is paid to the color of the bean than to its quality or even to its flavor. But even on these terms the Hawaiian coffee can hold its own. A recent shipment of coffee to the San Francisco market from these islands was pronounced by experts at that point to be the finest coffee which had been received in San Francisco this year. Even at the present prices, selling our coffee in competition with that imported from Brazil and other South and Central American countries, planters who are both good farmers and good business men can at least get a good rate of interest on their investment. Any factor which will lead to a broadening out of our market, and especially any change in the coffee trade which will permit the sale of the Hawaiian coffees on a basis of their quality, will do much toward settling up this land with American citizens. If our planters can secure the average price of 12 cents per pound for their entire coffee crop there would be nearly as much money in it as in a successful sugar plantation. It means a great deal to this Territory that our people on the mainland should render that

assistance which is in their power toward the building up of a strong farming class in these islands. If the people in the United States will buy our coffee, which is really of very superior quality, in fact better than the coffees ordinarily placed on the market, aid to the coffee industry would be far more permanent than if the industry were artificially fostered by the payment of a bounty.

PUBLICATIONS.

During the year two regular bulletins were published and a new series of press bulletins established. Bulletin No. 3 of the regular series, entitled "Insecticides for use in Hawaii," was issued by the entomologist to meet the general demand for information in regard to this line of agricultural investigation.

Bulletin No. 4, on the "Cultivation of Sisal in Hawaii," was prepared by the assistant agriculturist. It treats of every phase of the cultivation of the sisal plant. Both of these papers are in part compilations, but also contain the results of work carried on at the station.

The press bulletin series is intended to contain notes of minor importance, reports of preliminary experiments, and compilations from the publications of other experiment stations and scientific institutions of immediate interest to the farmers and planters of Hawaii.

The numbers issued during this fiscal year are as follows:

No. 1, "The Function of the Experiment Station."—This contains a résumé of the Congressional acts relating to the establishment of experiment stations and a statement of the needs of this newly established organization.

No. 2, "The Castor Beans."—This describes the method of cultivation, the soils and fertilizers required, the uses to which the oil is put, the fertilizing value of the cake remaining after the oil is extracted, and notes in regard to its introduction into Hawaii.

No. 3, "Preliminary Experiments with the 'Quick Blight' of the Potato."—This gives the results obtained from the first experiment with the quick-blight disease of the potato in the Kula district.

No. 4, "Na Hoao No Ke Pale Ana I Ka Pala O Ke Kalo."—This is a translation into the Hawaiian language of a synopsis of bulletin No. 2, concerning the root rot of taro, in order to make the results of the taro experiment available to the native growers.

No. 5, "Manila Hemp or Abáca."—This is a republication of Farmers' Bulletin No. 4, published by the Philippine bureau of agriculture in Manila. It gives many facts in regard to the cultivation of Manila hemp of interest to farmers and planters in Hawaii. There are a considerable number of Manila hemp plants now in cultivation in these islands. This compilation gives much desired information in regard to methods of cultivation of this important fiber plant.



FIG. 1.—HAWAII STATION—THE HAMAKUA FOREST.



FIG. 2.—HAWAII STATION—FOREST DESTRUCTION BY OVERGRAZING.

FARMERS' INSTITUTES.

The farmers' institute work inaugurated during the previous year has continued to develop. Four regular quarterly meetings were held by the local institute of the Wahiawa colony. The interest evoked by farmers and planters and also by the business men of the community in the success of this organization has been extremely gratifying. The increased numbers in attendance made it possible to begin the holding of both afternoon and evening sessions at the last meeting of the year. The papers presented before this society have been very carefully prepared, and have in all cases elicited much discussion. The second regular meeting of the year was held at the Kamehameha schools in Honolulu. The average attendance has about doubled during this year as compared with the first. The Territorial legislature at its recent session appropriated the sum of \$300 for the publication and distribution of the papers presented before this organization during the next biennial period. The Hilo Agricultural Society has shown equal growth, both in attendance and in interest. Other societies will be organized in other portions of the territory as soon as there is a demand for them. A large number of local societies of this character will prove an extremely important factor in the development of the agricultural resources of these islands.

WORK IN OUTLYING ISLANDS.

Thirteen trips to the other islands of the group, including Kauai, Molokai, Mani, and Hawaii, were made by the special agent in charge and his assistants during the last twelve months. The regions covered were: From Lihuo to Waimea on Kauai; the Kula, Wailuku, and Makawao districts on Maui; the Hilo, Hamakua, Kohala, Waimea, and Kona districts on the island of Hawaii, and the western half of Molokai. There are still a number of districts which have not been visited by any member of the station staff, as the Hanalei district on Kauai, the Hana and Lahaina districts on Maui and the Kau side of the island of Hawaii, nor has any member of the station visited the smaller islands of Lanai, Kahoolawi, and Niihau. A number of short excursions were made to various parts of the island of Oahu.

FUNDS.

Besides the appropriation of \$12,000 from the United States Treasury this station received during the fiscal year the sum of \$600.85 from sales of the various products of the station. This sum largely increased the amount available for the purchase of books and apparatus. The money received from this source was turned into the United States Treasury, from which it was reappropriated under the provisions of the act of Congress permitting the use of such moneys for the maintenance of the station.

The legislature of the Territory of Hawaii, at its session during the closing months of the fiscal year 1903, made liberal appropriations to assist this station. The items set apart for use during the coming fiscal period were as follows: Ten thousand dollars for "assistance to Federal Experiment Station," the sum appropriated for the first six months of this period to be expended under the direction of the Territorial board of agriculture and forestry; \$2,000 for salary of chemist; \$1,500 residence for chemist, and \$3,000 for an office, laboratory, and library building, making a total of \$16,500 to be expended for the benefit of this station during the two years ending June 30, 1905. This very liberal appropriation of funds will be of great assistance in carrying on whatever investigations are undertaken for the advancement of the agriculture of these islands.

ENTOMOLOGICAL INVESTIGATIONS.

Probably the most discouraging problem confronting those seeking to establish diversified farming in these islands is the injury to the crops from insect attacks. The two main industries as well, the production of sugar and stock raising, pay unwillingly an immense yearly toll because of these pests. To meet the many demands made upon the station for help from this source an entomologist was added to the station staff one year ago to organize a department of entomology and to begin investigations along this line. I will briefly summarize from his detailed report for the past year.

The greater part of the year has been spent in the organization of the department and in field work. The limited means of the station would not permit any great expenditure for laboratory equipment or breeding experiments; in fact, these were not essential at the beginning. The conditions surrounding the work were entirely different from those in a temperate climate, and at first glance it would seem that the many recommendations and conclusions arrived at in various parts of the United States in combating insect pests would not apply here in any way. It is evident, however, that the same principles governing the work elsewhere are applicable in Hawaii, but the methods must be changed to meet the local conditions. The most striking difference between the conditions here and elsewhere is the continuous presence of the injurious species. This fact applies to the fauna in general, accounted for not only by the perennial food supply, but also by the evenness of the temperature and rainfall, there being no long-continued spells of hot, cold, wet, or dry weather. The injurious species are, with few exceptions, introduced from abroad. Their having no natural check as regards climate, and being freed for the most part from their natural enemies that preyed upon them at "home," together with the continual food supply and lack of active and

precautionary measures to subdue them, accounts for the unusual numbers in which they occur.

It is obvious why no active measures have been considered for these various pests. The dominant industry has been a single field crop and it has yielded until now such unusual returns that it has not been necessary to grow alarmed over the loss through insect pests and other sources. Moreover, the subjection of pests to field crops depends not so much on active measures to destroy them as preventative methods in cultivation. Until the recent alarm over the leaf hopper (*Perkinsiella saccharicida*) the sugar cane has been particularly free from insect pests, the cane borer (*Sphenophorus obscurus*) being the principal source of loss. The persistence of the Chinese gardeners has enabled them to raise the few common vegetables they offer on the market despite the onslaught of pests. The pineapple and sisal industries already established are free from any serious pests, as are also the taro and rice, while the banana and coffee industries have not been checked by insect attacks. With the attempt to encourage and establish other paying crops, for example, the more choice varieties of vegetables, field crops such as watermelons, corn, potatoes, etc., the tropical fruits which thrive so well here, and the citrus fruits, comes the necessity of studying their foes to be found here and methods of their control.

The work on Hawaiian entomology in the past has been purely technical with the exception of ascertaining the native home of certain pests and determining, collecting, introducing, breeding, and disseminating their predaceous and parasitic enemies. Work of this character has been carried on here for the past ten years under the direction of Prof. A. Koebele, the eminent entomologist of the Territory. This work is highly desirable and has added greatly to the knowledge of the importance of the predaceous and parasitic forms in checking injurious species. Without going into a discussion of the limitations of this line of work, it is sufficient to say that the control of the injurious insects can not be left to this method entirely. The many requests for help before and since organization of this department is proof of that fact. A study of the life history and habits of the injurious insects, the extent of their injury, the symptoms of their attack, and the comparative resistance of different varieties to the attack, along with remedies, both active and precautionary, to check them is, to say the least, an equally important line of investigation.

There was an entire lack of literature on economic entomology, and despite the fact that an immense amount of technical literature on Hawaiian entomology is in existence, it was not available. Aside from various reports by Mr. Koebele in *The Planters' Monthly*, dealing for the most part with his introductions from abroad of beneficial species and several references in *Insect Life*, the balance consisted entirely of foreign publications widely separated as regards place and time of

publication. The effort to obtain a working reference library has resulted thus far in procuring the available publications on economic entomology from forty of the State experiment stations, and a complete set of the various publications of the Division of Entomology, U. S. Department of Agriculture, including some of the early reports of the commission of entomology, the Smithsonian Institution publications on entomology, and various papers and reports of Messrs. Koebele and Perkins. A bibliography of Hawaiian entomology is being prepared, and the effort to procure all available references will be continued.

A collection of the injurious insects has been started, arranged in metamorphosis cases to illustrate their life history before farmers' institutes and at lectures. About 100 lantern slides have also been purchased or prepared for this same purpose, illustrating the injurious and beneficial insects, their life history, the difference between biting and sucking insects, how the injury is wrought, and the methods and the machinery used in combating the injurious ones.

The entomologist during the year has visited the four principal islands of the group and made a personal study of the problems facing those attempting to raise the various crops. The result is quite a large amount of data on several of the most serious pests. Recommendations were made following the methods employed in other parts of the United States. In many instances the entomologist prepared the mixtures and applied them himself. Many difficulties were met; for example, many of the more active mixtures used elsewhere without injury against scale insects at a time when the plants are not in leaf—that is, “winter washes”—can not be used here where the plants are constantly in leaf, the frequent showers necessitating using mixtures not easily washed away, and also spraying more often than elsewhere. Many of the precautionary measures taken elsewhere—for example, fall plowing for the cutworm and exposing the mature forms to severe cold, rotation of crops, etc.—are eliminated here, where no cold seasons exist or where, as in some cases, crop follows crop throughout the year. The fruits are confined to small plantings about homes. In combating the pests of these trees the returns would not justify any great expenditure of time or money. This necessitated obtaining apparatus which would be efficient, yet low enough in cost to make it feasible to purchase it, throwing out of the consideration the larger and more efficient outfits. After many trials a “bucket outfit,” supplied with an extension rod and extra length of hose, was found to meet the present demand.

There was great need here of having in convenient form some of the formulas of the standard remedies and directions for applying them intelligently. Accordingly a bulletin entitled “Insecticides for use in Hawaii” was written, treating of what seemed to be only of interest



FIG. 1.—HAWAII STATION—PAPAYA TREE.



FIG. 2.—HAWAII STATION—NATIVE ORANGE TREE.

here and not attempting to go far beyond the present demand. The idea was not to present anything new, but to give as much of the vast amount of the available literature on this subject as would be useful. The bulletin, Bulletin No. 3 of this station, mentions in the introduction the seriousness of some of the insect depredations in Hawaii; emphasizes the importance of precautionary measures in cultivation; it distinguishes between the two classes of insects, biting and sucking, which feed on the external parts of plants; it describes spraying apparatus and explains how to spray successfully, and gives the standard insecticides for both classes of insects, with directions for making the mixtures and applying them. That the bulletin met a popular demand has been shown by acknowledgments received from those on the regular mailing list and frequent requests for additional copies.

The entomologist has visited during the year the Wahiana colony, island of Oahu, to investigate the so-called "melon fly" (*Dacus cucurbitæ*); the Kula district, on the island of Maui, where a plant louse (*Aphis* sp.) threatened the corn crop; Waimea, island of Hawaii, where cutworms belonging to the family Noctuidæ (species of the genus *Agrotis*) had driven several holders of small places to abandon their claims, and all crops, more especially garden crops, were severely attacked; Makaweli, island of Kauai, to conduct spraying experiments to check a scale insect (*Mytilaspis pinniformis*) on citrus trees; Kōkōala, Hamakua, and Hilo districts, island of Hawaii, to investigate the work of a leaf hopper (*Perkinsiella saccharicida*), a recent pest causing great alarm to the sugar planters; and Makawao, island of Maui, where the Japanese "rose" beetle (*Adoretus umbrosus*) and another beetle, the so-called "Olinda bug" (*Aramigus fulleri*), destroyed many newly imported trees. The Japanese "rose" beetle obtained its name because it has made the growing of roses practically impossible except in favored localities, but it is equally destructive to grapes. Both beetles are general feeders and many plants and shrubs suffer from their work.

Observations have been made and spraying experiments conducted in and about Honolulu to check several of the scale insects seriously attacking fruit trees. The report for the year contains valuable data on these various pests, together with the suggestions offered for their control. Much of this information has been disseminated among the people in the farmers' institute meetings and through the reports of the local press.

Other injurious insects mentioned are the peach scale (*Diaspis amygdali*); *Aspidiotus aurantii* on citrus trees; *Siphanta acuta*, locally known as the "torpedo fly," on the mango; the sugar-cane borer; the larva of a beetle (*Sphenophorus obscurus*), and a leaf hopper of the corn (*Dicranotropis maidis*).

The mosquito question is a serious one in Hawaii. No attempt has been made to destroy them, simply protection from the adult being practiced. The introduction of the insect into Hawaii, its distribution and abundance in the Territory, has been worked out. Determinations made by Mr. Coquillett, of the Division of Entomology, U. S. Department of Agriculture, gives, besides the common mosquito (*Culex pipiens*), two species of the dangerous yellow-fever genus *Stegomyia*, the Cuban yellow-fever species (*Stegomyia fasciata* and *S. scutellaris*). The entomologist has given several lectures illustrated by lantern slides on the life history and breeding places of mosquitoes and the methods used elsewhere to destroy them. He is taking a leading part in the campaign recently started under the direction of the board of health and department of public works to lessen the number of this pest in Honolulu, and has in preparation a bulletin on the mosquitoes of Hawaii, the result of breeding experiments in the laboratory, and observations in the field.

This department has rapidly outgrown the small space allotted to it at the beginning of the year. For the coming year's work an insectary in which to carry on breeding experiments and to observe more accurately the metamorphosis of certain species is in course of construction, and more laboratory room with additional equipment will be given.

Acknowledgments are given to Dr. L. O. Howard, Entomologist of this Department, for determinations made of specimens sent to him during the year, and to Prof. V. L. Kellogg, of Stanford University, for many valuable suggestions made by him in organizing the department while visiting the islands one year ago.

ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION FOR 1903.

By FRANK D. GARDNER, *Special Agent in Charge.*

INTRODUCTION.

The following pages give, in general terms, the progress of the work of the Porto Rico Agricultural Experiment Station for the year ended June 30, 1903. The appropriation made by the United States Congress for the year was \$12,000. For the year ending June 30, 1904, however, this amount has been increased to \$15,000, and now equals the sum which is appropriated annually to the experiment station in each of the States and Territories. The insular legislature also made an appropriation of \$2,700 for the past year, to be used as follows: Drainage, \$800; fencing, \$500; tobacco investigations, \$500; coffee investigations, \$500; irrigation, \$300; and painting, \$100.

As stated in the last report, the station did not secure possession of its new location until the last week in June, 1902. Considerable of the work of repairing was, therefore, done during the present year and paid for out of funds from the same year. The setting aside of a considerable area of Government land in the northeast part of the island for a forest reserve, as recommended in our last report, has been effected through the proclamation of the President, dated January 17, 1903, and is known as the Luquillo Forest Reserve. It has been placed under the care of the Bureau of Forestry of this Department, and is thus the first forest reserve to fall under the administration of this Department.

Mr. C. R. Newton, clerk and stenographer to the station, resigned January 1 to accept a more responsible position as official stenographer to the supreme court of Porto Rico at San Juan. His place has been filled by Mr. E. C. Howe. Mr. P. A. English, farm foreman, resigned in February to take a place in the Treasury Department, and his place has been temporarily supplied by Mr. E. G. Bowersox. An examination has been held for the position of farm superintendent and it is probable that an appointment will be made to said position in a short time.

Negotiations have been underway for some time in reference to the employment of a horticulturist, but thus far no one has been appointed. The horticultural work has been pushed vigorously, however, by Mr. O. W. Barrett, but to the necessary neglect of his special investigations in botany and entomology.

The station is now well and permanently located, and a large number of important investigations are under way, as may be seen from the list of experiments on a following page. With the appointment of two more good men to take charge of horticulture and animal industry, respectively, the organization of the station will be very satisfactory and the field of investigations well covered.

IMPROVEMENTS AND EQUIPMENT.

The improvements have consisted chiefly in the repair and painting of buildings, building of fences, and repair and cleaning of roads and ditches. A barbed-wire fence of 3 new wires and posts of native wood at intervals of 15 feet has been built around the tract known as the "Ochenta;" the length of the fence is about 2,600 meters, or a little more than 1.5 miles. Forty rods of woven-wire highway fence have been erected along the highway leading from the city to the station farm. As a result of the appropriation made by the insular legislature for fencing, 550 rods more of the woven-wire fencing has been purchased and, at the present writing, is being erected.

The stable and wagon shed, which was brought from Rio Piedras, has been erected on the site of the old stable which has been torn down.

A plant house 60 by 80 feet in area has been constructed of poles, wire, and tent cloth, such as is used for tobacco shade. The uprights of native wood were cut from the farm, as were also the bamboo stringers, thus making the cost of the structure small. The most serious objection to the framework has been that the nodes on the bamboo have worn holes through the canvas. The nodes project very little, but they are so hard and cutting that it is recommended that they be carefully smoothed off wherever they come in contact with the canvas.

The additions to the equipment consist principally of small implements, such as hoes, spades, shovels, etc., together with a new set of work harness, a drainage level, and a new typewriter and bookcases for the office.

DRAINAGE.

Approximately 900 feet of underdrainage of bamboo has been put down in the experimental field and, up to date, has given excellent results. The nodes were cut out of the poles, thus securing hollow cylinders about a foot in length and from 2 to 4 inches internal diameter. These were sorted so as to place the larger ones at the mouth of the drain and the next smaller ones were gradually used as the head of the drain was approached. They were placed at an average depth of about 3 feet and were at once covered. They work quite as satisfactory as tile drain, but, of course, they can not be expected to last for a great length of time. In connection with the appropriation made

by the insular legislature for drainage the coming year, it may be said that negotiations thus far indicate that it will be more economical to purchase a small-sized tile machine and manufacture the tiles on the ground.

CLEARING AND PREPARATION OF LAND.

During the year two fields have been cleared of a considerable growth of brush, weeds, and grass, and plowed. The first, consisting of about 15 acres, was prepared during October and November, 1902, and was planted to general crops such as rice, corn, beans, cowpeas, alfalfa, and kafir corn. These crops were planted chiefly as a preliminary preparation of the land for future experimental purposes. Owing to the lateness of planting, the severe attack of many insects, and the prolonged drought which prevailed from January 1 to May 15, these crops gave very poor results. After they were harvested the land was laid out into permanent plats, each 20 by 50 meters, or one-tenth of an hectare in area. Between the ends of plats was left roadways 5 meters in width for the purpose of turning rows and passage with wagons, etc., and along the sides was left a space 1 meter in width. A number of these plats have been planted to permanent crops, while others have been subdivided and used for annual crops, fertilizer tests, etc.

The second field, more recently cleared and plowed contains about 25 acres, and is to be used for a general fruit orchard. A portion of this was planted to general crops in May, as soon as the rains began, but the results have been similar to those in the other field and indicate that very little may be expected from the first crops planted on land that has for many years been allowed to go to weeds and brush. The difficulty on such land is largely due to insects, especially the larval stage of various kinds, which seem to be abnormally abundant. With clean cultivation a great many of them disappear in a few months.

TRAVEL.

During the year the special agent in charge made a trip to Washington to prepare his last annual report and consult with the Director of the Office of Experiment Stations in regard to the general policies of the station. He also made one trip to San Juan, in February, to secure the introduction of an appropriation bill before the local legislature, which was then in session. Two trips were made during the year to the "La Carmelita," where the coffee experiments are being conducted, and one trip to Lajas, in company with Mr. Barrett and Professor Earle, to study the pineapple industry at that place. In addition to the above the station botanist and entomologist made a trip to Venezuela and Trinidad to study the cacao industry and collect

seeds of various economic plants for the station. He also made two trips in company with Prof. F. S. Earle, one to La Carmelita and one to Maricao, to study various plant diseases, as well as various short excursions for the purpose of collecting specimens.

SCOPE OF INVESTIGATIONS.

Tropical horticulture along a number of lines has appealed to us as being a very important, if not the most important, branch of investigation that the station could undertake. On account of the long time required for such work to give results, it was decided that it should be commenced at the earliest date. As previously stated, no horticulturist has thus far been secured, and Mr. Barrett, botanist and entomologist for the station, has been designated to look after the work, with the result that, since its inauguration, it has occupied nearly all of his time. The entomological and botanical investigations have, therefore, been necessarily neglected, although the demand for them, especially the entomological, has been as urgent as ever. In several instances insects have completely devoured a considerable area of field corn and cowpeas, as well as small plats of sweet corn, string beans, and other tender vegetables. Plant diseases of a fungus or bacterial character have been responsible for the total failure of several attempts to grow tomatoes, egg plants, and Irish potatoes. Scale insects of various kinds are prevalent on most of the young citrus orchards in various parts of the island.

The following experiments are now in progress:

Experiments at Porto Rico Experiment Station.

Ex- peri- ment No.	Kind of plant.	Nature of experiment.	Ex- peri- ment No.	Kind of plant.	Nature of experiment.
1	Bananas.....	Test of varieties.	19	Coffee.....	Effect of plant dis- tances.
2	.....do.....	Test of fertilizers.			With and without shade.
3	Yautia.....	Test of varieties.	20	.....do.....	Methods of pruning.
4	.....do.....	Test of fertilizers.	21	.....do.....	Tests of varieties.
5	Cassava.....	Test of varieties.	22	Citrus fruits.....	Orchard tests of miscellaneous tropical fruits.
6	Yams.....	Do.	23		
7	Cacao.....	Do.	24	Coffee leaf miner.	Extermination of.
8	Leguminous crops	Comparative value of.	25	Pineapples.....	Test of varieties.
9	Vegetables.....	Miscellaneous test of.	26	Bananas.....	Effect of plant dis- tances.
10	Grasses.....	Tests of.	27	.....do.....	Methods of propaga- tion.
11	Cucumbers.....	Effect of fertilizers on.	28	Tea.....	Test of varieties.
12	Tomatoes.....	Do.	29	Rubber.....	Do.
13	Fiber plants.....	Test of kinds.	30	Changa.....	Methods of extermi- nating.
14	Forestry experi- ments.		31	Florists' bulbs....	Test of varieties.
15	Tobacco investi- gations.		32	Miscellaneous na- tive crops.	Tests of.
16	Coffee.....	Treatment of old plan- tation.			
17	.....do.....	Seedlings, effect of fer- tilizers.			
18	.....do.....	Tests of varieties.			

Reports on the major part of the above list of experiments will be found in the reports of Mr. Barrett, under the heads of horticulture,

botany, and entomology, or of Mr. Van Leenhoff, under the head of coffee investigations.

The following experiments, on which brief report is made, have been under the immediate supervision of the writer, assisted by the farm foreman.

LEGUMINOUS CROPS.

On account of the impoverished and bad physical condition of much land in Porto Rico, considerable attention has been given to leguminous crops, with the hope of securing something that would serve in preventing, to a large degree, the severe washing of the soil, which now takes place on the steep lands and, at the same time, enrich the nitrogen content of the soil as well as improve its physical condition. As stated in the last annual report, alfalfa, common red clover, crimson clover, and alsike clover were tried at Rio Piedras, but that all were failures, except alfalfa, which was still living when the grounds were abandoned.

In November, 1902, about one acre was seeded to alfalfa on the experimental grounds at Mayaguez. A good stand was secured and the plants made a good growth. The dry season, which continued from January 1 to May 15, retarded the growth, but many of the plants bloomed. When the rainy season began, the plants made a new and vigorous growth for a short time, after which they nearly stopped growing and since which time they have barely managed to survive. No tubercles can be found on the roots, and it is believed this is the cause of the poor success. Arrangements have been made to inoculate some seed for a new plat, also to treat the soil of the present field. Two attempts have been made with each of three varieties of Turkestan alfalfa, with failure as a result.

Cowpeas have been tried a number of times, but always with failure. No tubercles have been found on their roots, and they are much troubled by a small leaf hopper (*Empoasca mali*) and a stalk borer.

Soja beans have done much better, but have not given large returns. The leaves, being covered with hairs, have been less subject to the attacks of the leaf hopper, but have been considerably damaged by a small spotted beetle which eats holes in them.

Beggar weed was tried, but only a few plants secured; these few have grown fairly well.

Velvet bean has done best of all. The vines when planted in drills one meter apart have completely covered the ground with a dense growth and given a good yield of beans.

The sword bean has also done well, but grows slower and for a much longer period than the velvet bean. Of all the legumes tried the velvet bean is the most promising and should prove a good plant for building up the nitrogen content of the soil.

GRASSES AND FORAGE PLANTS.

Two species of gramma and one of Bermuda have been tried for lawn purposes. The last named seems to be the most satisfactory. It spreads rapidly and is much finer and of better appearance than the gramma.

Teosinte, Johnson grass, and Bermuda grass have been sown on experimental plats and, although poor stands have been obtained, the indications are that either teosinte or Johnson grass will grow well and make good forage, although it is a question if either would equal the malojillo and Guinea grass that are now much used for that purpose.

Corn will grow and make fair yields on good land. The attempts made by the station to grow it on land that for years has been in weeds, grass, and brush has failed on account of the bud worms which work in the terminal bud, devouring the newly formed leaves. The native flint corn seems more resistant than yellow dent from the States, while sweet corn is so very tender that many attempts to grow it have resulted in absolute failure.

Kafir corn, sorghum, and broom corn have done fairly well and have proven more resistant than corn.

VEGETABLES FROM NORTHERN-GROWN SEED.

The following sorts have been planted:

Beets, beans, cabbage, cantaloupe, carrots, cucumbers, eggplant, lettuce, onions, potatoes, peas, radishes, sweet corn, squashes, tomatoes, spinach, watermelon.

Of most of these several varieties have been tried, while some have been repeated with various kinds of fertilizers, detailed reports of which will be given in coming publications.

Beets, cantaloupe, eggplant, beans, onions, potatoes, peas, sweet corn, spinach, tomatoes, and watermelons have either failed or done so poorly that nothing need be said about them.

Cabbages did well when care was taken to hand pick worms; without such care they are a failure.

Carrots made a moderate growth and gave roots of a fair quality.

Cucumbers were difficult to get through the early stage, but when well established have given fair yields.

Lettuce is also difficult to start on account of the heavy rains followed by scalding sun which destroys many very small and tender plants. When established it grows well, but frequently is more or less strong to the taste.

Radishes have grown without difficulty.

Tomatoes, potatoes, and eggplant have all been affected in a similar way by a bacterial or fungus disease which has proven fatal before the fruiting stage was reached.



FIG. 1 —PORTO RICO STATION—EXPERIMENTAL PINEAPPLE PLANTATION.



FIG. 2.—PORTO RICO STATION—EXPERIMENTAL BANANA PLANTATION.

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FERTILIZERS.

Fertilizer tests have been in progress on a variety of crops, but thus far only a few of the crops have been harvested, so that results are yet undetermined.

Among the crops on which fertilizers have been tried may be mentioned yautias, bananas, coffee nursery beds, coffee trees, cucumbers, tomatoes, vegetables, and citrus nursery stock.

TEST OF VARIETIES OF PINEAPPLES.

There is no typical pineapple land on the station farm, so the plants have been set on a dry, gravelly ridge, which most nearly approached it. (Pl. XVIII, fig. 1.) The following varieties have been planted: seven hundred plants of Cabezona, 150 plants of Pan de Azucar, 150 plants of Caraquena, 200 plants of Red Spanish, 200 plants of Smooth yenne, 50 plants of Egyptian Queen.

The first three varieties are common on the island and were secured Lajas, which is the most noted pineapple district that we have. The remaining three were secured from Reasoner Brothers, Florida, through the courtesy of Prof. P. H. Rolfs, of the Bureau of Plant Industry, United States Department of Agriculture.

COTTON.

No systematic experiments have been undertaken with cotton, for the reason that considerable experimenting has been undertaken by persons who have recently organized the Walker Industrial Cotton Company. Their experiments extended to all parts of the island and to planting of different sorts every month through the year. They report about 8,000 acres planted during the present season, of which a large percentage promised a good crop. They recommend the Sea Island variety as best for planting and the month of May as a preferable time. The following extract is from the January, 1904, Crop Reporter of the United States Department of Agriculture:

The London Times of December 21 quotes Mr. A. A. Paton, vice-chairman of the British Cotton Growing Association, as saying that he has sold, through Messrs. F. Zerega & Co., 13 bales of Porto Rico cotton at 14½d. (29 cents) per pound, and 33 bales more were to be delivered in Liverpool the same week. The first lot was sold in small parcels, so that cotton spinners might test its rare qualities. It was expected that from 1,000 to 1,200 bales in all would be shipped this season and that the prices realized would be such as to stimulate cotton growing throughout the West Indies. Messrs. F. Zerega & Co. presented the association above named with all the seed obtained from the cotton sold and it is to be distributed among the West India Islands. Mr. Paton is said to regard this Porto Rico cotton as the finest ever imported into Liverpool. A sample of it was submitted to an experienced broker who did not know its origin and was classified by him as good Sea Island.

METEOROLOGICAL OBSERVATIONS.

As stated in the last report, the meteorological instruments of the United States Weather Bureau, which were in the care of the voluntary observer at Mayaguez, were transferred to the station. The record is being continued and weekly and monthly reports sent to the central office in San Juan. A set of instruments has also been placed at the "La Carmelita," where the coffee experiments are being conducted, also an extra rain gauge, which is placed at the extreme upper end of the estate, at a considerably greater elevation than the first, for the purpose of ascertaining the effect of elevation on rainfall.

The following table gives the monthly rainfall at each of four places since the establishment of the United States Weather Bureau in the West Indies. These include the latest available data, and, being at the east and west ends of the island, as well as at the north and south sides, they show the extreme variation in rainfall to which the island is subject.

Rainfall (inches) in Porto Rico, as recorded by the United States Weather Bureau, January, 1899, to August, 1903.

Locality.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Hacienda Perla:													
1899.....	7.19	3.98	6.51	18.78	6.72	11.47	10.55	9.92	15.13	16.53	28.13	4.92	140.06
1900.....	12.05	3.67	4.43	23.34	18.70	18.55	11.04	11.95	15.30	15.83	8.36	8.70	151.92
1901.....	6.07	1.85	11.03	7.05	16.26	25.34	33.58	8.19	16.10	14.16	16.43	11.67	167.73
1902.....	13.99	.24	7.25	9.94	19.83	32.92	10.08	8.13	10.06	6.06	13.03	9.64	141.17
1903.....	4.37	2.41	3.88	7.55	10.28	7.40	14.40	10.61					
Mean.....	8.73	2.43	6.62	13.33	14.35	19.13	15.93	9.76	14.22	13.14	16.48	8.73	150.22
San Juan:													
1899.....	2.92	.80	2.29	6.09	2.59	7.23	7.53	10.38	13.66	10.21	11.81	2.10	77.61
1900.....	3.93	2.13	1.57	5.92	3.83	7.53	6.33	7.00	3.05	8.11	4.50	2.39	56.29
1901.....	4.36	.50	4.60	.66	4.84	7.05	10.98	8.59	7.39	8.30	9.55	8.43	85.25
1902.....	12.45	.09	4.08	6.09	13.97	12.22	4.61	4.66	4.85	3.13	5.65	7.16	78.96
1903.....	2.09	1.44	4.26	3.07	4.54	2.18	7.13	8.41					
Mean.....	5.15	.99	3.36	4.36	5.95	7.24	7.31	7.80	7.23	7.43	7.87	5.02	74.52
Mayaguez:													
1899.....							14.41	19.02		8.73	3.52	1.04	
1900.....	1.49	1.06	1.21	5.44	6.14	11.03	13.11	14.02	7.44	12.47	2.99	4.20	83.57
1901.....	2.19	.58	5.72	.58	11.87	10.44	17.06	9.86	13.00	11.27	12.84	2.08	97.49
1902.....	4.67	.39	.13	10.85	16.56	8.33	7.62	5.80	7.60	5.82	9.14	4.48	81.39
1903.....	2.13	.33	2.19	1.74	11.58	12.42	10.86	7.89	7.77				
Mean.....	2.62	.59	2.31	4.65	11.53	11.30	12.61	11.31	8.95	9.57	7.12	2.95	87.48
Yauco:													
1899.....						3.50	3.81				3.72		
1900.....	6.05	.28		.91	1.70	18.50	5.61	2.96	2.75	5.86	3.25	2.74	
1901.....	3.04	1.50	3.16	.37	3.78	1.27	9.72	1.30	9.57	3.36	7.52	1.52	49.11
1902.....	3.14	.12	.65	7.97	10.59	15.45		2.98	4.60	3.58	1.82	3.74	
1903.....	1.26	.33	3.80	3.67	5.04	1.09	3.11	4.22					
Mean.....	3.37	.55	2.53	3.23	5.27	7.96	5.56	3.61	5.64	4.26	4.07	2.66	49.11

ADMINISTRATIVE WORK.

As time goes on the administrative work of the station increases. The correspondence has increased about 40 per cent over that of the first year. The total number of letters written during the year has been something more than 1,000. The duties as disbursing officer, together with the keeping of separate accounts for the Federal and insular appropriations, require in the aggregate considerable time. The detailed administration of the general field work, together with superintending the labor and keeping in order the general appearance of the farm and buildings, fully occupies the time of the farm foreman or superintendent and allows him very little opportunity even to carry out the details of experiments. The labor problem is quite different from that in the States. Labor, to be effective, requires constant and careful supervision. Without such supervision it accomplishes very little. There are far more workmen than places for them, and the best of them are quite satisfactory, considering the price, if given sufficient supervision.

MISCELLANEOUS NOTES.

During May and June, 1903, the services of Prof. F. S. Earle, of the New York Botanical Gardens, were secured, to make a study of some of the most important pathological diseases which occur on the island. The results of his investigations are appended as a portion of this report.

About 300 bound volumes have been added to the library during the year and the unbound publications have been largely increased.

The mailing list now numbers approximately 1,000 names and is daily increasing.

At the present time the work of tobacco investigation for the coming year, under the appropriation made by the insular legislature, have been commenced and arrangements made to continue the same throughout the year.

PLANS FOR FUTURE INVESTIGATIONS.

Most of the work commenced during the year will necessarily continue for several years and is sufficient to fully occupy the time of the present station staff. It is desired, however, to secure two additions to the regular staff, i. e., a horticulturist and a live-stock specialist, and also to retain the services of the tobacco specialist, who has already begun preliminary investigations under the small appropriation made by the insular legislature, through the year. With these additions to the staff, considerable more important work might be undertaken.

TOBACCO INVESTIGATIONS.

The tobacco investigations as outlined for the year consist, first, of a survey of the tobacco conditions in all the principal tobacco-growing districts, and second, of some detailed experiments on a plantation near Aguas Buenas. (Pl. XIX, figs. 1 and 2.) It is planned to conduct experiments in the preparation of seed beds, comparison of plants from Porto Rican, Sumatra, Habana, and Connecticut-grown seed for the production of wrappers, comparison of growing wrappers with and without shade, methods of topping and pruning, effect of fertilizers on yield and quality of fillers, experiments in manner of curing, and also of fermenting. In short, the crop will be carried through from the seed to the product ready for the manufacturer. The cooperation of the United States Department of Agriculture would have been of great assistance in this connection, but, unfortunately, the appropriation for tobacco investigations was so restricted that it could not be used in the island possessions.

POMOLOGY.

As above stated, the investigations now begun in plant industry will be continued for some time to come. Prominence will be given, however, to pomology, and especially to the citrus fruits. An order has already been placed for 28 varieties of budded trees of orange, grapefruit, and lemon to be planted in the experimental orchard. As will be seen under the head of horticulture, seedlings from a variety of stock are now in the nursery and will form the basis of an elaborate investigation in the propagation of citrus stock for Porto Rico. For example, budding material from the best native orange ("china") that can be found will be uniformly budded onto stock of each variety that we now have to determine the best stock to be used. A considerable number of seedlings from what is now supposed to be the best stock will also be budded with a large number of standard varieties of orange to determine which is best suited to Porto Rico. Other experiments in reference to the best fertilizers to be used for orange trees, together with methods of soil management and the pruning of the trees, will also be inaugurated.

ANIMAL INDUSTRY.

It is doubtful if any work along this line can be commenced during the present year, because of the lack of funds. There is scarcely a doubt, however, but that the insular legislature will make provision for this line of work when the matter is properly laid before it. It will require a good man to take charge of the work and a considerable outlay at the start for the purchase of animals and the installation. The most promising lines to begin with would be dairying, swine husbandry, and poultry. There is also a demand for the breeding of



FIG. 1. PORTO RICO STATION—SHADE-GROWN TOBACCO NINETY DAYS AFTER PLANTING.



FIG. 2.—PORTO RICO STATION—SHADE-GROWN TOBACCO AFTER SEVERAL PRUNINGS.



FIG. 3.—PORTO RICO STATION—CASSAVA NINE MONTHS AFTER PLANTING.



FIG. 4.—PORTO RICO STATION—YAUTIA, EIGHT MONTHS AFTER PLANTING.

larger horses for road purposes, and especially for good-sized mules for work purposes. At present all the interior road freighting and the plowing of land is done by oxen. Dairying should be confined, first, to the development of a good local milk supply, and second, to the manufacture of butter and cheese for home consumption. It would not be wise to attempt to do more than develop the industry for home consumption, for it presents certain difficulties which are more easily overcome in a temperate climate.

Swine industry should be, first, the introduction of a suitable breed for the climate, and second, to ascertain what tropical crops are best suited for producing pork.

The poultry should be improved in size particularly and with reference to both meat and eggs.

SOIL INVESTIGATIONS.

The soil survey, which was begun last year and of which a map has been prepared, should be continued. To be successfully carried on this work would require the cooperation of the Bureau of Soils. Certain restrictions laid upon the appropriation for the Bureau now prevents its cooperation in this regard.

Soil improvement by the application of manures and growing of leguminous crops will be fully investigated at the station grounds.

The cooperation of the various bureaus of the Department with the experiment station is desired to the fullest possible extent, and a scheme for such cooperation along various lines will be suggested for approval of the Secretary.

The cordial financial support which has thus far been accorded the station by both the National Congress and the insular legislature, together with the interest manifested by the planters in requesting its publications, is very encouraging and bespeaks for the station a high degree of usefulness.

It is confidently believed that the people of Porto Rico will meet the demands of the experiment station by adequate appropriations with which to enlarge its usefulness from year to year.

REPORT OF O. W. BARRETT, ENTOMOLOGIST AND BOTANIST.

During July attention was directed principally toward experiments with the changa (*Scapteriscus didactylus*) and with insecticide and fungicide tests in the vegetable plats. In August the experimental plats were harvested and a collection of the native crops in the vicinity was made and sent to the new station grounds at Mayaguez; some attention was also given to the herbarium and insect collection.

On account of the condition of the land at the new grounds and the time required to fit the soil for crops very little ecological work was attempted, the greater part of the time from September to December

being spent in studying the economic plants of the district and in laying out nurseries and propagating plats of same. The trials of native vegetables, which were not completed in Rio Piedras were resumed. From January to July the work has been almost entirely of a horticultural nature. It has seemed best to give prominence to pomology, and a fairly complete collection of the native fruits, as well as many varieties of tropical and subtropical fruits from other countries, has been made; forage, fiber, and vegetable crops have been considered of secondary importance. Over 300 varieties of plants have been under investigation during the year.

RESULTS OF WORK.

The herbarium now contains about 325 species of economic plants; though but very little time could be allowed for botanizing, many interesting species have been secured in or near the station grounds.

Over 100 species of injurious insects have been studied. No attempt has been made to include the noneconomic species as yet.

A collection of the native woods has been commenced; about 100 cabinet specimens and a small number of "trunk sections" are already assembled.

As it was found impossible to prevent damage to the herbarium specimens from mold and insects when kept in ordinary cases, zinc-sheathed cases have been substituted with complete success.

Further study of the changa has resulted in no important results beyond those given in Bulletin No. 2.

Two trips were made in May, in company with Prof. F. S. Earle, of the New York Botanic Gardens, for the purpose of studying the fungus diseases of coffee and cacao. Three days were spent at the coffee substation.

In March a trip was made to Venezuela and Trinidad for the purpose of studying the methods of cacao culture in use in those countries and of securing seed of the principal varieties of the plant. Seven days were spent in Venezuela and five in Trinidad. Ninety-one varieties of seeds and plants were brought back, nearly all of which were new to Porto Rico. Although the culture of cacao, in Trinidad especially, is far better managed than it is in this island, it was concluded that our soils and climate compare very favorably with those of that island, and that with proper interest and attention the industry can be made very profitable here. In St. Vincent the manufacture of starch from arrowroot was witnessed. Two visits were made to the botanic gardens, St. George, Grenada, and a call was paid to the botanic station, Scarborough, Tobago.

In April a cheese-cloth tent 60 by 80 feet was erected after the style of the ordinary tobacco-shade tent. It was intended for use as a propagating shed, but as the texture of the cloth has proved too light to withstand the heavy rainfall and strong winds and too open-meshed to

afford sufficient shade, it has been on the whole a failure. Moreover, the atmosphere within being slightly more humid and warmer, conduces to fungus diseases among the seedlings. Previous to this several small palm-leaf sheds were used successfully.

PLANT COLLECTIONS.

The following collections of economic plants have been assembled:

BANANA PLANT.

About 3 acres of wind-sheltered hillside having a western exposure were set aside for the collection of bananas and plantains. This plot is intended for a variety test, a source for stock distribution of the more valuable kinds, and as an experiment in methods of planting, cultivation, and fertilizing (Pl. XVIII, fig. 2). In regard to the methods of planting, it has been found that the "ñame" (short portion of stem base with corm-like rootstock) was preferable for planting in dry soil; that the "tallo" (3-foot section of stem with root) gave best results in wet soil, and that the "pichón" (2-3-foot sucker or offshoot from stem base) was the most convenient for general purposes. The number of offshoots produced by each of these methods was nearly the same after eight months. Contrary to the popular belief it was indicated that drying the roots in the sun for several days previous to planting was injurious to the vitality of the plant and considerably retarded its sprouting. It is possible, however, that sun-baking may be more or less effective in preventing decay of the root when planted in wet soil. Very few of the "pichones" failed to start into growth within one month after setting, but about 5 per cent of the roots planted by the other methods rotted. Liberal quantities of wood ashes, phosphate rock, nitrate of soda, rotted coffee pulp, and stable manure were used without apparent effect. The plants which have made the best growth thus far are those growing in a heavy red clay which apparently contains very little humus though much moisture.

An experiment to determine the effect of allowing few and many offshoots from the parent plant to remain is in progress; three years will be required to terminate this experiment.

Although but five varieties of this most important fruit are commonly offered for sale in the markets of the island, an unexpectedly large number of the following native varieties has been procured from various parts of the island:

Enano.	Colorado Blanco.	Plátano Hartón.
Enano Doble.	Rosa, or Dátyl.	Plátano Trescientos.
Chamaluco.	Dominico.	Plátano Enano.
Chamaluco Pato.	Manzano.	Plátano Cuarenteno.
Guarán, or Gigante.	Prieto.	Plátano Morado.
Guarán Doble.	Inglés.	Guayabo.
Morado, or Colorado.	Congo.	Cenizo.
Morado Doble.	Congo Morado.	

The following varieties were received from the Jamaica Botanic Gardens in January. It is probable that there are four to six reduplications of the native varieties under these names:

Martaban.	Pisang Rám-Kela.	Cinerea.
Pisang Serch.	Pisang Kudjo Hudang.	Guindy.
Pisang Almcido.	Pisang Palembang.	Lady's finger.
Pisang Kelat.	Red.	Lady's finger (Pashorgar).
Pisang Rajah.	China.	Discolor.
Pisang Soosoo.	Martabanica.	Rubra.
Pisang Ambon.	Champa.	Apple.
Pisang Mass.		

YAUTIA COLLECTION.

The collection of Yautia (*Xanthosoma* spp.) which was begun in Rio Piedras has been more than doubled, and it is believed to now contain practically all the known varieties. (Pl. XIX, fig. 4). This most valuable root crop appears to be confined to Tropical America, though perhaps the oldest cultivated plant in the world. Experiments have been begun in methods of planting. With one "short season" variety nine kinds of fertilizers have been used; the plant does not readily respond to chemical fertilizers, but stable manure has given very good results.

The collections consists at present of the following 25 varieties:

Rollisa, or Isleña.	Cimarrona.	Rollisa Ancha.
Blanca.	Palma.	<i>Alocasia marshallii</i> .
Amarilla, or Huevo.	Gris, or Amarilla de Maya-	<i>Alocasia batavensis</i> .
Punzera.	güez.	1 Venezuelan variety.
Prieta, or Morada.	Martinica.	2 Trinidad varieties.
Guayamera colorada.	Isleña de Ponce.	6 Jamaica varieties.
Guayamera verde.	Orqueta.	

The question of synonymy can not be fully worked out until the roots are harvested, but judging from the leaf and petiole characters, there is not a great amount of duplication among these names.

Though even the natives of Porto Rico commonly believe that the Yautia never flowers, a photograph of the flower of the "Martinica" variety was taken at the coffee substation (Pl. XX, fig. 3), and evidence was obtained that at least three other kinds have been seen in bloom.

The average market price ($1\frac{1}{2}$ to 2 cents per pound) of Yautia is about twice that of Taro, or "Malanga."

The very rare and interesting plant which is popularly known "Yautia del Monte," and which had been considered an *Amorphophallus*, has been found to be *Dracontium asperum*, an Aroid from South America, not known to be native elsewhere in the West Indies. Two colonies of the plant occur at the station grounds, and specimens 6 feet high have been measured, the flower photographed, and the seed collected. The corm, sometimes 1 foot in diameter, is dug and eaten



FIG. 1.—PORTO RICO STATION—CITRUS NURSERY.



FIG. 2.—PORTO RICO STATION—COFFEE SEEDLINGS BEING TRANSFERRED TO PLANTATION.



FIG. 3.—PORTO RICO STATION—FLOWER OF *XANTHOSOMA PERAGRINA*, THE YAUTIA MARTINICA.

in times of scarcity of other roots; when boiled, it resembles a squash in color and flavor and seems to be free from raphides.

YAMS.

The following varieties have been assembled:

From Jamaica Department of Agriculture:

Barbados Table, Lucia.

Yampie, or Indian, St. Vincent.

Negro.

Collected in Grenada, British West Indies:

White Lisbon, St. Kitts.

White, or Water, St. Lucia.

From Hawaii Experiment Station:

Uhi.

Hoi.

Native varieties:

Gunda (*Dioscorea bulbifera*), Congo.

Mapnes Morado (*D. trifida*), Gulém.

Guinéa, Agna.

Purchased: Chinese (*D. divaricata*).

Six species are represented in this collection. Most of the varieties, however, belong either to *Dioscorea aculeata* or *D. alata*.

An interesting yam bean, believed to be *Calopogonium caruleum*, is under investigation. For unknown reasons it is very seldom cultivated, but is said to yield large roots of first-class quality.

An exchange of the yam varieties has been instituted between Hawaii and Porto Rico.

MISCELLANEOUS NATIVE CROPS.

Two varieties of the native papaw (*Carica papaya*) are being compared with a variety the seeds of which were received through Mr. G. N. Collins from Costa Rica.

The plat of "Maraca," or edible canna (*Canna edulis*), is proving less productive at Mayaguez than at Rio Piedras. The small plat at the latter place yielded roots at the rate of about 15 tons per acre. A large Hesperid butterfly (*Calpodex ethlius*) feeds upon the leaves, and a black fungus, the colonies of which occur in circular patches on the upper side of the leaf, is also injurious.

A plat of the rare root crop known as "Llerén" (*Calathea allouya*) is making a good growth. Though difficult of cultivation, this peculiar plant is highly prized by the natives of the interior, and is even sold in the streets of some of the large towns, the crisp, nut-like tubers ranking with peanuts in popularity.

The native "Malanga" (*Colocasia antiquorum esculenta*) is under comparison with the "Dasheen" (*Colocasia* sp. ?) of Trinidad. Our plant thus far appears superior to the imported one.

Arrowroot (*Maranta arundinacea*) is frequently found growing wild about the plantations; it responds readily to cultivation, but requires a fairly rich soil to produce a profitable yield.

The sword or horse bean (*Canavalia gladiata*) has given good results as a soiling crop.

Cowitch (*Mucuna pruriens*) produces a heavy growth of vine, but can not be utilized as a soiling crop on account of the poisonous bristles on the pods in place of the "velvet" of the velvet bean.

Two plats of sweet ginger (*Zingiber officinale*) made a good growth in sandy soil at Rio Piedras; the seed roots, however, remained some four months in the ground before sprouting. In clay loam at Mayaguez the crop has proved a failure.

A plat of Hedionda (*Cassia occidentalis*) did not respond to cultivation in the tests at Rio Piedras. The seeds of this plant are commonly mixed with coffee by the poorer classes, both for its reputed medicinal qualities and as an adulterant.

BULBS.

The following varieties of bulbs were received from a wholesale florist in Hoboken, N. J., for testing at Rio Piedras:

Lilium longiflorum, *L. longiflorum giganteum*, *L. longiflorum eximium*, *L. harrisii*, *Freesia refracta alba*, "White Roman" hyacinth, and "Paper White" narcissus.

Although the bulbs of the Easter lily (*L. harrisii*) were so badly affected with a fungus disease prevalent in Bermuda that about 25 per cent were destroyed upon arrival, fully 75 per cent of those planted reached a height of 12 to 18 inches and bore one or two (rarely three) good-sized flowers each. Practically all the plants showed traces of the fungus disease which has caused such ravages in the Bermuda fields during the last few years. Many plants, however, ripened seed, and about 85 per cent of the bulbs dug in August were apparently almost free from the disease. The average number of the "seed" bulbs produced on the stem above the old bulb was three to five; these appeared much more healthy than the old bulbs.

It is quite possible that the Bermuda or Easter lily can be successfully grown in the island, and at the present price (about \$8 per thousand) the business should be fairly profitable. When planted in November a crop may be harvested in July or August, in time for the September trade.

According to our experiments, a light but rich sandy loam is preferred. Shade proved deleterious. The change did practically no damage to this crop. Neither of the two fertilized plats responded appreciably.

Of the *Longiflorum* varieties the *Gigantium* produced more flowers; both of these varieties were somewhat later in flowering than the *Harrisii*, and both showed serious traces of fungus disease.

Another case of lily bulbs (*L. harrisii*?) was received from the same firm and planted at Mayaguez in September, with negative results.

The Roman hyacinths failed utterly; only about 1 per cent of the bulbs flowered. We suspect that both the "seed" and the phenological conditions were not good.

About 75 per cent of the narcissus bulbs flowered, but did not make a satisfactory growth thereafter and produced only a very small number of weak side bulbs.

Out of some 500 freesia bulbs planted not more than 25 per cent produced plants above 3 inches in height, and not one flower was produced.

The Barbados lily (*Hippeastrum equestre*), or "Mapola," is a weed in many places in Porto Rico, though it retails at 15 cents in the Northern market. Experiment proved that full-sized bulbs could be grown 4 inches apart in ordinary soil. Thus in a plat 11 feet square 1,000 salable bulbs could be grown with very little attention, and even at one-half cent apiece their cultivation should be highly remunerative, provided a market could be depended upon.

Three varieties of fancy-leaved caladiums were found growing wild in the station grounds at Rio Piedras. This plant is native to tropical America, and appears exceedingly hardy and very prolific of offsets. Small plants of the size which retails in the North at 10 to 15 cents were easily grown on the experimental grounds at Mayaguez. Cuttings of the parent bulb sprout readily, and in a moist, rich soil make a very rapid growth.

MISCELLANEOUS IMPORTED CROPS.

Seeds of the tree tomato (*Cyphomandra betacea*) were secured in Caracas, Venezuela, and the plants, though very sensitive to climatic influences, are growing slowly.

Plants of *Passiflora edulis*, from seed received from Jamaica Department of Agriculture, are doing well. Seed of a species of *Passiflora* were collected in Caracas; the seedlings are growing slowly.

Four kinds of tea—Japan, Anam, Amoy, and Dragon's Pool—received through the United States Department of Agriculture, have made a slow growth and many plants died in the dry season.

Nine varieties of Venezuelan beans have been tested.

CASSAVA.

A dry, gravelly patch of clayey soil underlaid with "Tosea" limestone was chosen for this collection. (Pl. XIX, fig. 3.) No fertilizer has been applied, but the plants have responded well to the clean cultivation given them.

The collection consists at present of the following 25 varieties:

From Jamaica Department of Agriculture:	Native varieties:
Rodney.	Negrita.
Robby Hanson.	Coriana.
Bunch of Keys.	Ceiba.
Black Bunch of Keys.	Pata Paloma No. 1.
Brown Stick.	Pata Paloma No. 2.
Yellow Belly.	Pata Paloma No. 3.
Fustic.	Pana.
White Top.	Dulce.
Mass Jack.	Migucla.
New Green.	Brava de Palo Verde.
Auntie Gracie.	From the Bureau of Plant Industry, U. S.
Grey Stick.	Department of Agriculture:
St. John.	Florida Old Sweet.
Garden Sweet.	

FIBER PLANTS.

The four 2-inch seedlings of Manila hemp (*Musa textilis*) which were received in January from the Bureau of Plant Industry, United States Department of Agriculture, made a very slow growth at first, but are now beginning to throw out offshoots and one of the plants is 1 meter high.

The bulbils of the indigenous "maguey" (*Furcraea foetida*) which were set in December, 1902, have reached a height of 18 inches, while suckers of the same species have attained nearly 3 feet.

The Cuban maguey (*F. cubensis*), known as "Cocuisa," has made a slower growth; the very spiny and comparatively short leaves, as well as the slow growth and poorer grade of fiber, render this plant unworthy of cultivation in this district.

Twelve small plants of the Bahama sisal (*Agave rigida sisalana*) were received in December from the Bureau of Plant Industry of the United States Department of Agriculture and have made a fair growth in a poor stony soil; they are now 1½ feet in height and are beginning to throw out the subterranean suckers.

Plants of the Indian madár (*Calotropis procera*), which grow wild in many parts of the island, have made a fairly good growth in stony soil.

The "Santa Maria," or *Sansevieria guineensis*, which also occurs wild in several districts, has been a failure owing to the too dry and poor soil. Much interest has been awakened in this fiber recently, but it is feared that it can not be grown in the poor soil which is so well suited to the maguey.

"Caïllo" (*Urena sinuata*), a common wayside plant belonging to the Malvaceæ, makes a very rapid growth—about 2 meters in three months—and together with the following species is commonly used in making cheap cordage, thongs, etc.

Urena lobata, the wild jute of the fields, grows rapidly and can

readily be trained into a straight, few-branched, woody plant of 2 to 3 meters.

Plants of the true jute (*Corchorus capsularis*), grown from purchased seed, are making a fine growth and fruiting heavily.

A few seedlings of a rare shrub believed to be *Daphnopsis philippiana* were secured at the coffee substation and are now ready for permanent setting. Ropes made from the fiber of the bark of this plant can not be bitten off by horses or dogs on account of the abundance of raphides contained in the fiber cells.

Roots of the famous Arouma (*Ischnosiphon arouma*) were collected in the forest at Arima, Trinidad, but the attempt to cultivate the species has been a failure here as in Trinidad.

Young plants of the "Jipijapi" (*Carludorica* sp. ?) were obtained in Caracas, Venezuela; this species is said to produce the best grade of leaf for making "Panama" hats in Colombia and Venezuela. They are now growing in the cloth tent, but probably require greater humidity and more shade to attain perfect development.

Four old roots of *Carludorica palmata* have been received from the Bureau of Plant Industry, United States Department of Agriculture, one plant of which survives a "black-rot" disease.

Contrary to the popular belief experiments have shown that plants of the Porto Rico hat palm (*Inodes causiarum*) may be easily raised from seed; these seedlings, however, should be transplanted from the wet sand before they reach a height of 6 inches.

At the coffee substation the leaves of the "Palma de Sierra" (*Acrista monticola*) are made into cordage, hammocks, bottoms for cot beds, etc. If a market could be found for this coarse material a new industry would be opened; the supply is practically inexhaustible in the mountainous districts, especially in the Luquillo Forest Reserve. The young leaves of the royal palm (*Roystonea borinquena*) could be used similarly.

FOREST PLAT.

An experiment has been begun to determine whether a hill, barren of trees and composed of the common red clay over limestone, can be profitably afforested with native or introduced species of timber trees. About 4 acres have been set with seedlings, cuttings, and "volunteers" of 1 to 3 years of age; 100 square feet are allowed to each tree.

The present rank growth of grass and weeds serves as partial shade for the very young plants; as soon as required a space is cleared around each tree, the rubbish being used as a mulch during very dry weather.

A few species have been included, not so much for their timber values as for other economic purposes, as carob, logwood, kopok, bay rum, copal, etc.

The following species have been received from or collected at the coffee substation:

Cedro hembra (<i>Cedrela odorata</i>).	Arroyo.
Cedro macho, or purple cedar.	Arrejón.
Leche prieta (<i>Diphelis</i> ? sp.).	Sabina (<i>Magnolia splendens</i> ?).
Mato.	Almendrón (<i>Prunus occidentalis</i>).
Motilla (<i>Sloanea</i> sp.).	Guayabota (<i>Eugenia</i> ?).
Yaya (<i>Orandra</i> ? sp.).	Aguacatillo.
Jaya.	Hueso blanco.
Nuesmoscado (<i>Nectandra</i> sp.).	Corcho prieto.
Canelo, or wild cinnamon.	Tabonuco (<i>Dacryodes hexandra</i>).

The following species have been received through the United States Department of Agriculture:

Sissoo (<i>Dahlbergia sissoo</i>).	Brachychiton (<i>Sterculia diversifolia</i>).
Quebracho (<i>Schinopsis lorentzii</i>).	Carob (<i>Ceratonia siliqua</i>).
<i>Grabowskia glabra</i> .	Silk-cotton ("Ceiba cascadea").

From Madagascar Experiment Station: Copal (*Trachylobium verrucosum*).

From purchased seeds:

<i>Catalpa orata</i> .	<i>Albizia julibrissin</i> .
<i>Catalpa speciosa</i> .	<i>Gymnocladus canadensis</i> .

From California Forestry Station:

Sydney Golden Wattle (<i>Cassia floribunda</i>).	Oleander Wattle (<i>Acacia nerifolia</i>).
Golden Wattle (<i>Acacia pynantha</i>).	Red Gum (<i>Eucalyptus rostrata</i>).
Black Wattle (<i>Acacia mollissima</i>).	Blue Gum (<i>Eucalyptus globulus</i>).
Australian Blackwood (<i>Acacia melanoxylon</i>).	Manna Gum (<i>Eucalyptus viminalis</i>).
	Karri (<i>Eucalyptus diversicolor</i>).
	Sugar Gum (<i>Eucalyptus corymocalyx</i>).

From Trinidad Botanical Gardens: Logwood (*Hæmatoxylon campechianum*).

From Grenada Botanical Gardens: *Erythrina* sp.?

From Caracas, Venezuela: *Erythrina* sp.?

From San Juan, Porto Rico: Lebbek (*Albizia lebbek*).

From vicinity of experiment station, Mayaguez:

Lechecillo (<i>Chrysophyllum moupprenum</i>).	Mameyuelo (<i>Ardisia</i> ? sp.).
Cieneguillo (<i>Eugenia</i> ?).	Indio.
Hoja Menuda (<i>Myrcia</i> ? sp.).	Almendrón Cimarrón.
Capá Sabána (<i>Cordia</i> sp.?).	Acetuna (<i>Symplocos</i> sp.).
Roble (<i>Tecoma pentaphylla</i>).	Jagua (<i>Genipa americana</i>).
Palo de Pollo.	Acacia.
Higuerillo (<i>Vitex divaricata</i>).	Quitarín, or Abelluelo (<i>Colubrina ferruginosa</i>).
Cojoba (<i>Piptadenia peregrina</i>).	Guásima (<i>Guazuma guazuma</i>).
Moca (<i>Andira inermis</i>).	Guayabillo (<i>Myrcia</i> ?).
Jácana (<i>Lucuma multiflora</i>).	Algarrobo (<i>Hymenaea courbaril</i>).
Guaraguao (<i>Guarea trichiloides</i>).	Bocare (<i>Erythrina micropteryx</i>).
Espino (<i>Zanthoxylum clava-herculis</i>).	Cafeillo (<i>Faramea odoratissima</i>).
Goano (<i>Ochroma logopus</i>).	Cañafistolo (<i>Cassia fistula</i>).
Yagruma Macho (<i>Didymopanax morototoni</i>).	Santa Maria (<i>Thespesia populnea</i>).
Malagneta (<i>Ananomis caryophyllata</i>).	Pomarosa (<i>Jambosa jambos</i>).
Auzú (<i>Ananomis</i> ? sp.).	

RUBBER PLAT.

In January 100 one-year-old seedlings of *Castilloa elastica* were received from the United States Department of Agriculture; 96 of these were brought through the long drought and have been trans-

planted into rows 12 feet apart in a 1-acre plat. In May some 500 seeds of *Castilloa* sp. were received through Mr. G. N. Collins from Nicoya, Costa Rica; these had been packed in moistened powdered charcoal and were germinating upon arrival; 100 of these rapidly growing seedlings will be transferred to the plat in September. 100 will be set in nursery rows, and the remainder will be held for distribution.

Fifteen seedlings of the West African silk rubber (*Funtumia elastica*) were obtained in September from seed received from the Trinidad Botanical Gardens; a few of these plants were lost during the dry season. The average height of the remaining specimens at nine months from seed is fully 1 meter; the unpruned form has a large, roundish head of bifurcating branches.

Seeds of Ceará rubber (*Manihot glaziovii*), received from Dr. John Gifford, have as yet failed to germinate.

Plants have been raised from cuttings of the native wild fig (*Ficus populnea*?) and will be set in the plat together with "volunteer" plants of same species procured in the vicinity.

CACAO PLAT.

At the "Moca" estate, one of the largest cacao walks in the hills near Spanish Town, Trinidad, a study was made of the varieties of cacao grown there, the propagation and cultural methods in use, and the fermentation and drying processes used in preparing the seeds for the market. Some 25 selected fruits, representing the 12 principal varieties, were obtained and brought back in almost perfect condition. The pods were sponged off en route with formalin solution as often as indications of decay were noticed. Seeds of the Alligator cacao (*Theobroma bicolor*) alone were lost.

The coolie labor system, which has been so well managed by the Trinidad Government, was also studied, but no form of it appears to be applicable in Porto Rico. Under this system the cacao trees are purchased from the Hindoo coolie, who is furnished seed, land, tools, and the right to build a hut and till a small tract for his own benefit. The trees may be sold by the coolie to the estate owner at any time after one year, but are usually cared for until bearing (three to five years) by the coolie, who must live constantly on the estate. The coolies are expected to do "piece" and day labor when required by the superintendent. On account of the coolie's propensity for saving his wages to his personal physical detriment, a large part of the daily wage is paid either in rations on the estate or through store checks.

No attempt toward artificial control of the ferments of the curing processes was noted. The popular impression is that no two lots of the "beans" can ever be treated the same way because of the differences between the seeds—all varieties being sweated together—as well as temperature and humidity differences. No white seeds were

observed. About 3 pounds of "beans" per tree is the average annual crop in Trinidad; that is, an acre containing 300 trees will produce about half a ton of cocoa, worth about \$100. The life of a tree is indefinite, and a plantation should yield a practically continuous crop (8 to 13 annual pickings) for at least twenty-five years.

About half of the Trinidad cacao seeds were planted in large, shallow boxes of earth without fertilizer and the other half were planted in bamboo pots, one seed to each pot; each method was found to have some advantages over the other. The "damping off" was more easily controlled in the pots than in the boxes, but about 30 per cent of the seedlings were lost from this disease. In June about 350 selected seedlings were transferred into the plat without loss. The site selected for the experiment is a ravine, the sides of which were densely covered with second-growth shrubs and trees. This natural shade will be gradually cut out and replaced by "Bocare" (*Erythrina micropteryx*)—one shade tree to four cacao trees.

Two varieties of the Porto Rico cacao—the common Colorado (probably identical with the Trinidad "Forastero") and the white-seeded variety having yellow pods—are also represented in the collection. The white-seeded cacao is considered more difficult to grow, but of superior quality.

The Trinidad varieties are the following:

Calabacillo, red	Criollo-Forastero, red.
Forastero-Cundeamor.	Criollo-Forastero, yellow.
Criollo, red.	Criollo-Calabacillo.
Large, smooth yellow.	Forastero, 5-angled, large seed, small, thin
Forastero, Ceylon, brown.	pod, acute tip.
Lapp Forastero.	Forastero, low grade.

FRUIT NURSERIES.

Experiments in cutting propagation of various varieties of native fruits have been made. A roofed shed open to the air on all sides is indicated as the proper locus for further work in this line.

Species from Trinidad:

Bilimbi (<i>Avorrhoa bilimbi</i>).	Cannon-ball tree (<i>Couroupita guianensis</i>).
Kokam butter (<i>Garcinia indica</i>).	
Carap, or crab-nut (<i>Carapa guianensis</i>).	Madagascar tamarind or Voa-Vanga (<i>Vangueria edulis</i>).
Nutmeg (<i>Myristica moschata</i>).	Apple calabash (<i>Parmentiera cereifera</i>).

From Venezuela:

Sweet lemon (*Citrus medica limia*), a tree bearing medicinal seeds.

From Curaçao:

Small, sweet mango (*Mangifera indica*).

From Grenada:

Tahiti apple (*Eugenia malaccensis*).

Nutmeg (*Myristica moschata*).

From United States Department of Agriculture:

Jujube (*Zizyphus* sp.).
 Five varieties figs (*Ficus carica*).
 Pistachio (*Pistacia vera*).
 Wild pistachio (*Pistacia nutica*).
 Anatto (*Bixa orellana*).
 Pond apple (*Anona glabra*).
 Cherimoyer (*Annona cherimolia*).

Kai apple (*Diospyros* [*Aberia*] *caffra*).
 Cashew apple (*Anacardium occidentale*), from Beira, Portuguese East Africa.
 Bengal fig (*Ficus oppositifolia*).
 Coca (*Erythroxylon coca*).
 Cola (*Cola acuminata*).

Species obtained in exchange:

Cluster or Gúlar fig (*Ficus glomerata*).
 Java plum (*Eugenia* sp.?).
 Surinam cherry (*Eugenia mitcheli*).
 Amatungula (*Carrissa arduina*).
 Loquat (*Eriobotrya japonica*).
 French mulberry (*Morus alba*).
 Chinese cinnamon (*Cinnamomum cassia*).
 Camphor (*Cinnamomum camphora*).
 Cuban Ti-es (*Lucuma rivicola angustifolia*).

Mexican white sapote (*Cassimiroa edulis*).
 Chinese guava (*Psidium lucidum*).
 Guinea guava (*Psidium guineense*).
 Cabada guava (*Psidium guajava*).
 Cattley guava (*Psidium cattleyanum*).
 Sour guisaro guava (*Psidium guay-ava*).
 Calcutta apple guava (*Psidium pomiferum*).

Species collected in vicinity of station:

Ciruelo, or Spanish plum (*Spondias purpurea*).
 Jobo de la India (*Spondias dulcis*).
 Pear guava (*Psidium guajava*).
 Apple guava, or guayabo (*Psidium guajava*).
 Cereso (*Malpighia glabra*).
 Cerezas (*Cordia nitida*).
 Grosello, or Tahiti gooseberry (*Coccoloba disticha*).
 Calambreña (*Coccoloba nirva*).
 Mango (*Mangifera indica*), 3 vars.
 Aguacate, or alligator pear (*Persea gratissima*), 2 vars.
 Soursop, or guanábana (*Annona muricata*).
 Custard apple, or corazon (*Annona reticulata*).
 Wild custard apple (*Annona montana*?).
 Cashew apple, or pajuil (*Anacardium occidentale*).
 Mamee apple, or mamey (*Mammea americana*).
 Marimalade fruit, or mamey sapote (*Lucuma mammosa*).
 Nuez, or candle nut (*Aleurites moluccana*).
 Güinep, or quenepa (*Melicocca bijuga*).
 Genipap, or jagua (*Genipa americana*).
 Seagrape, or uvero (*Coccolobisuvifera*).
 Cocoa plum, or jicaco (*Chrysobalanos icaco*).
 Star apple, or cainito (*Chrysophyllum cainito*).

Guayabillo (*Calyptanthus*?).
 Sapodilla, or níspero (*Achras sapota*).
 Guerrero (*Eupatorium dalea*?).
 Betel-nut (*Areca catechu*).
 Sweet orange, or china (*Citrus aurantium sinensis*).
 Sour orange, or naranjo (*Citrus aurantium amara*).
 Bittersweet orange, or ingierta (*Citrus aurantium amara dulcis*).
 Rough lemon, or limón bobo (*Citrus medica gentiana* + *C. medica limon*?).
 Lime, or limón agrio (*Citrus medica acida*).
 Sweet lemon, or lima (*Citrus medica lumia*).
 Sweet lime, or limón dulce (*Citrus medica linetta*).
 Caracas sweet lemon, or lima (*Citrus medica lumia*?).
 Citron, or cidra (*Citrus medica gentiana*).
 "San Domingan" orange (*Citrus aurantium sinensis*).
 Bergamot orange (*Citrus aurantium bergamia*).
 Mandarin seedling orange (*Citrus nobilis*).
 Kumquat orange, (*Citrus japonica*), 2 varieties.
 Grapefruit, or toronja (*Citrus decumana*).
 Myrtle orange (*Citrus aurantium* var.).

The greater part of the above nursery stock, except the Citrus varieties, will be set in the 25-acre orchard, which is nearly ready for planting, during the months of September, October, and November (Pl. XX, fig. 1). The trees will be set in rows 25 feet apart and 15 to 25 feet apart in the row, depending on the variety.

There are now in the budding rows (three plants to the meter in rows 1 meter apart) the following: 1,250 limón bobo, 1,000 naranjo, 200 china, 100 ingiarta. These stocks will be ready for budding during the next rainy season. An experiment to test the comparative values of the above 16 (and other) stocks for budding with certain standard sweet oranges and the native Mayaguez "china" is contemplated.

SEED AND PLANT DISTRIBUTION AND ACQUISITION.

Several hundred packages of garden seeds received from the United States Department of Agriculture have been distributed to the rural schools and to estate owners.

Native bulbs, seeds, and roots have been sent to Hawaii, Honduras, and to several firms in California and Florida.

Collections of the three principal varieties of Porto Rican pineapples have been sent to the botanic stations in Antigua, Dominica, and Jamaica.

The botanic stations in the British West Indies have very generously offered to supply gratis to the Porto Rico experiment station the varieties of economic plants which may be obtained at their station grounds, a list of desiderata has been sent to Sir Daniel Morris, director of the Imperial Department of Agriculture in the West Indies, and to Mr. J. H. Hart, director of the Trinidad Botanic Gardens, and packages of seeds are being received at frequent intervals from the several British stations.

The two most valuable additions to our economic collections thus far have been the collection of bananas (22 varieties), taniel or yautia (6 varieties), yams (5 varieties), and cassava (14 varieties), secured from the Jamaica Department of Agriculture, and the collection of miscellaneous economic plants received from the Bureau of Plant Industry of the United States Department of Agriculture.

Besides Great Britain the only foreign country donating seeds or plants was Madagascar.

INSECT PESTS.

Insecticide experiments were carried on in July and August at Rio Piedras with the cotton bollworm, leaf hoppers, aphids, and the changa.

At Mayaguez the first entomological work to demand attention was

the eradication of the white ants, which, due to the semiabandoned state of the place, had become thoroughly established in the outbuildings, fence posts, and all mango and "jobo" trees in the vicinity. Over seventy-five nests were destroyed within 100 yards of the office building. As the arsenic treatment proved too slow and uncertain, recourse was had to burning with kerosene. A few ounces of the oil usually sufficed in dry weather to effect the entire destruction of a nest and all the insects therein. In a few cases the individuals which had been outside the nest at the time of its destruction returned and formed a small nest near the site of the old one. As many as eight queens were discovered in one nest, though four was an unusual number. The number of workers in a large colony was estimated to be from 50,000 to 100,000. The species has been determined as *Eutermes morio* (?). The winged form migrates from April to July. Live wood is very seldom attacked.

A smaller species, having hyaline instead of sooty wings, swarms in vast numbers in April, but no nest has been located yet.

It is recommended that all fence posts be well tarred before setting. The "poma rosa" (*Eugenia (Jambosa) jambos*) is especially liable to the attacks of white ants. The following kinds of woods may be used for posts in a "live" fence: Algarrobo (*Hymenæa courbaril*), jobo (*Spondias lutea*), bocare (*Erythrina micropteryx*), almácigo (*Bursera simaruba*), guayabo (*Psidium guayaba*), and molinillo or havilla (*Hura crepitans*). Of course some of these species will not take root in dry soil, but with a little care an ant-proof fence may be had which is practically permanent. The sprouting branches should be lopped off two or three times a year.

The changa has done more or less damage in the vegetable beds and nurseries. Repeated applications of the poisoned bait, as recommended in Bulletin No. 2, have served, however, to keep this enemy in check. Traps made by sinking 5-gallon kerosene tins just below the surface of the soil and lightly covering the open tops of same with small sticks, grass, and earth proved utterly useless.

CUTWORMS.

Comparatively little damage has been done by these insects, though a species of *Prodenia* has been quite numerous and hand-picking of the larvæ had to be kept up for some weeks in the Central American rubber-seed beds. Larvæ of an undetermined species were sent in from the coffee substation and reported as doing considerable injury in the coffee-seed beds.

The cotton bollworm (*Heliothis armiger*) destroyed a field of corn in November and December. Dropping or spraying Paris green in water into the heart of the young plants resulted in killing great

numbers of the larvæ, but the moths continued in force till February. From 1 to 4 larvæ on the average inhabited each "spear." Several species of flies were attracted to the frass thrown up by these larvæ and some of the smaller species bred therein. When much diluted, kerosene emulsion, whale-oil soap, and creolin solution were also tried, but although effective in killing the larvæ, seriously injured the corn itself.

COFFEE INSECTS.

The coffee leaf miner (*Leucoptera (Ceniostoma) coffeella*) has been studied with the hope that some means might be discovered for successfully combating this most serious enemy of the coffee in Porto Rico; but as yet no parasites of this minute moth have been observed and in only one instance were the larvæ found dead in the galleries between the upper and lower surfaces of the leaf, and no insecticide has been found applicable. This pest is now evenly distributed over the whole island; 20 per cent to 40 per cent of the leaves on each tree are affected, and sometimes 6 or more larvæ are found in the same burrow.

An experiment has been begun at the station grounds in Mayaguez to determine the result of removing all affected leaves in a plat of badly infested trees. Data are kept showing the number of leaves removed, the cost of the required labor, the average cost per tree, the reduction of the percentage of infested leaves by each picking, and an estimate of the benefit realized subsequently in the plat. The pickings will be repeated as often as reinfection renders necessary.

The red scale (*Lecanium hemisphaericum*) has proved troublesome locally, but as soon as the number of scales becomes so great that the individuals are clustered together closely on the branch, a cream-colored fungus usually appears and annihilates the whole colony. The hyphæ of this interesting and important fungus (which is being studied by Prof. F. S. Earle, of the New York Botanical Gardens) rapidly spread over each scale, the young and adults alike, and extends radially to some millimeters distance beyond. Very few coccinellid larvæ have been observed among the scales.

A plant louse (*Aphis*?) is occasionally detrimental to the young coffee leaves, but it is usually kept in check by the larvæ of a fly (*Syrphus*?).

A scale (*Orthezia* sp.), parasitic on the roots of unhealthy coffee trees, was observed at the coffee substation.

A fulgorid bug, having the entire body and wings covered with a grayish-white powder and consequently often mistaken for a moth, is rather common, but seldom found in large colonies. It attacks the young branches.

INSECT ENEMIES OF CITRUS STOCK.

The red scale (*Lecanium hemisphaericum*) is probably the most common scale on the orange here; since it infests many other plants it is liable to appear in any orchard at any time. Two to four applications of kerosene emulsion are usually necessary to rid a badly infested tree of this pest. This scale is sometimes parasitized by a hymenopter, as well as by the common whitish fungus, which is proving to be of great importance.

The purple scale (*Mytilaspis citricola*) is very common in all parts of the island; it is parasitized by a "red-fruited" fungus (*Sphaerostilbe coccophila*) and a black slow-growing fungus (*Myriangium duriei*), which was first observed at Naguabo and which is fairly common at Mayaguez.

The chaff scale (*Chionaspis citri*) is common everywhere on orange and lime.

Aspidiotus aurantii is rare but apparently spreading.

Ceroplastes floridensis was noted only in an orchard near Naguabo.

Chrysomphalus aonidium is rarely met with as yet.

Dactylopius citri is not common.

Aspidiotus articulatus occurs commonly in the eastern and northern districts.

Generally speaking the orange growers in Porto Rico are not giving sufficient attention to the scale pests in their groves; the spraying is entrusted to native laborers, who are certain to leave more or less unsprayed surface on each tree. One of the most promising groves has been very seriously injured by allowing the pests to become thoroughly established. Moreover, the insecticides are not always carefully made, and worse still, perhaps, old and badly infested native seedling trees are frequently left standing in or near the new orchards to breed and distribute endless generations of scales to the nurseries and young trees. Thousands of acres in the north part of the island have been planted with oranges in the past two or three years, and though it is natural that in this hurry and optimistic excitement such dangers are overlooked by the average planter, the prospective injury from scale insects in these new orchards might be very greatly lessened by a more careful attention to their present requirements.

In some groves considerable damage is being caused by a small brown ant which bites the bark and feeds upon the gum which exudes from the wound. Small branches are frequently girdled, and the loss of sap and gum through the numerous open wounds in time weakens the young tree. When not too close to the trunk of the tree a nest may be destroyed by pouring into it a few spoonfuls of carbon bisulphid and then covering with a wet gunny sack, but young trees are sometimes killed by the use of too much of the liquid near the roots.

Kerosene emulsion poured into the openings of a nest just after a rain is also effective in killing or driving away the ants. Fresh air-slaked lime placed close about the base of the trunk will for a time hinder the processions. Cloth bandages tarred or wet with creolin, corrosive sublimate solution, or crude carbolic acid solution are of some temporary value only; the two latter should be applied over a plain bandage of cotton batting.

The larvæ of a weevil determined as *Eroophthalmus spengleri* was found eating the bark from the taproots of orange stock in a nursery near Rio Piedras. The adult insect is common throughout the island not only on citrus stock, but on nearly all kinds of fruit trees. A handful of air-slaked lime at the foot of the tree deters the female from entering the ground to deposit her eggs at that point. Hand picking will probably be found necessary to keep this pest in check for the next few years.

During the dry season two species of Lamellicorn beetles seriously damage the foliage of citrus stock and bananas. A boy with a lantern and a pail containing a little kerosene and water can easily collect a large per cent of these insects in an orchard by visiting the trees in the early part of the evening; for large trees a sheet spread under the branches may be used by two or three boys to better advantage.

INSECT ENEMIES OF MISCELLANEOUS FRUIT TREES.

Diaspis pentagona has proved very destructive to peach trees in the east part of the island; this species also attacks mulberry and papaw. Although not difficult to control, the native makes no attempt to rid his dying papaws of this "piojo" (louse).

Aleurodicus minima injures the wild guava (*Psidium guayava*) in some localities.

Asterolecanium pustulans has appeared on the fig (*Ficus carica*) at the experiment station.

An undetermined scale (*Vinsonia*?) occurs on the rose apple (*Jambosa jambos*).

The Guanábano (*Anona muricata*) is everywhere affected with *Lecanium hemisphaericum*; and an aphid frequently joins its efforts to weaken the tree, and by its habit of attacking the flowers probably prevents the "setting" of many fruits.

A thrips and a *Dactylopius* have injured Pajuil seedlings (*Anacardium occidentale*) in our nurseries; a few of the plants were killed in spite of kerosene emulsion treatment.

An aphid appeared on the *Castilleja* plants, but was exterminated by a lace-wing fly (*Chrysopa*?).

The flower clusters of cacao (*Theobroma cacao*) are frequently attacked by a brownish aphid, and the punctured and weakened pedi-

cels and embryo fruits thus become very liable to the attacks of the pod-rot fungus.

Vinsonia stellifera occurs commonly on the cocoanut (*Cocos nucifera*). At Ponce many of these trees are dead or dying from attacks of *Aspidiotus destructor*. This scale is parasitized, however, to some extent by a Tineid moth, the larva of which forms a web over the scales on the worst-infested leaflets and gradually devours the entire colony, though not soon enough to save the life of the leaflet; attempts to rear this interesting insect have been unsuccessful thus far and but one imago was seen in situ.

MISCELLANEOUS INSECT ENEMIES.

A cricket (*Grylloides nauticus*) has proved a serious pest in the station's nurseries and seed beds, many valuable plants having been cut off just above the ground. In one case freshly cut leaves were found in the burrow of this insect, which had thus adopted one of the chunga's (*Scapteriscus didactylus*) clever habits. A cricket, presumably this species, was reported as doing considerable damage in the coffee seed beds at the coffee substation.

A small fly (*Lonchaea chalybea*), previously known from Brazil, has caused much damage in the larval stage by boring into the terminal buds (rarely petioles) of cassava (*Manihot utilissima* and *M. palmata aipi*); hand picking is the only remedy since the openings to the burrows are closed by a granular, gummy secretion; the brittle terminal bud is broken off and dropped on the ground where the immediate "bleeding" and withering of the bud imprisons and kills the young maggots. Mature cassava plants are usually attacked by a small bug of the Tingitidae (*Atheus nigricornis* ?); the under surface of the full-sized leaf is the only part attacked and, therefore, successful spraying is exceedingly difficult, especially since the insect is possessed of great vitality. A brownish mite also causes injury to the young cassava leaf; the epidermis of the under surface of the basal portion of the blade is the usual point of attack. *Lecanium hemisphaericum* and an undetermined white scale have been noted on stems of cassava.

Practically no insect enemy of the yautia (*Xanthosoma* sp.) has been observed yet; however, a black aphid was found on a plant purchased as *Alocasia marshallii*, but believed to be a *Xanthosoma*, and a mite was noted on the upper surface of the leaf blade of a plant bought for *Alocasia batavensis*, but which appears identical with the common yautia known as "Guayamera."

The malunga (*Colocasia antiquorum esculentum*) is occasionally attacked by an aphid which is usually parasitized by a whitish fungus and a hymenopter.

A scale (*Daetylopius* ?) attacks the "heads" of Guinea yams at

Mayaguez. One variety of yam brought from the botanic gardens at St. George, Grenada, was badly affected with *Aspidiotus hartii*.

The minute leaf hopper (*Empoasca mali*) has been the severest insect enemy of beans and cowpeas; spraying is almost useless. *Agallia tenella* and several Tettigoniids have also injured beans and other small crops.

A lepidopterous stem borer has destroyed many plants in the bean plats and has greatly hindered the growth of the horse beans.

The bean leaf beetle (*Cerotoma denticornis*) is common.

Plutella maculipennis was very abundant on cabbage at Rio Piedras; it was controlled by repeated applications of "slug shot" reinforced with paris green.

A flea beetle (*Systema basalis*), in company with a root fungus, has ruined a plat of Russian sunflower at the station.

Larvæ of a weevil (apparently *Sphenophorus*) were observed in sugar cane at Ponce.

Protoparce carolina occurs commonly on tomato and tobacco throughout the island; the larvæ are usually killed by a thrust of a knife made from a Maya (*Bromelia pinguin*) leaf.

The melon worm Pyralid (*Diaphania hyalinata*) has proved a severe pest throughout the year, both at Rio Piedras and Mayagüez, on squash, cucumber, and melon; while small the plants can be kept from serious injury by hand picking the young larvæ in the buds and new leaves, but when the plants are mature this becomes a laborious task.

PLANT PARASITES.

Several species of *Loranthus* are common on various fruit and timber trees; in the vicinity of Ponce many fine trees were noted killed or dying from the parasitism of a white-fruited *Phoradendron*. The calabash (*Crescentia cujete*) is very frequently attacked.

A dodder (*Cuscuta americana?*) was with difficulty eradicated from a plat of alfalfa in the trial grounds of the station at Mayaguez. This species occurs commonly on low shrubbery, especially along the sea shore.

Bromeliads and orchids are occasionally found on coffee; these do little or no damage to the host, though causing a shabby appearance. Lichens and liverworts, however, undoubtedly injure the leaves and bark of coffee by retaining excessive moisture, obstructing respiration, and furnishing a foothold for various fungi; since these plants thrive only in very humid situations, the "opening up" to more light and better air circulation will soon ameliorate the condition of the "mossiest" patch of trees.

The Guamá (*Inga laurina*) is very frequently affected with a peculiar disease of the peduncle. This organ becomes excessively branched and, each branchlet being distorted and abbreviated, the infertile mass

of pedicles assumes a more or less spherical shape, becomes a harbor for coccids, ants, cockroaches, etc., and is believed by many peons to give rise to a "rust" disease of coffee growing beneath such shade trees. Although coffee does frequently die under Guamá trees badly affected with the peduncle disease, no etiological connection has been established between the two effects. The peduncle disease appears to be of a physiological rather than of the "witches broom" (*Exoascus*) type.

The Guaba (*Inga vera*), which is usually preferred for coffee shade, appears to have no enemy other than the fungus mycelium which sometimes attacks the roots of coffee and coffee shade trees in small areas in old plantations. It is, however, much less prolific than its related species, the Guamá, producing but one light and irregular crop of more or less imperfect fruits, instead of two heavy regular (May and October) crops of seeds in an edible pulp.

FUNGUS DISEASES.

The following fungi have proved more or less injurious during the year:

Cladosporium citri, damaging sour stock in citrus nurseries.

An undetermined "spot" fungus appearing on the under side of citrus leaves and resembling "melanose;" this disease occurs commonly throughout central Mexico in the old orange groves.

A red-spored "damping off" disease of citrus nursery stock in seed beds.

Stilbum flavidum on coffee at the coffee substation; not common.

A root disease of coffee caused by the subterranean hyphae of an undetermined fungus (*Polyporus?*). This disease spreads radially, killing the shade trees and nearly all plants in its course, but its progress is fortunately very slow. Ditching around the infected area is advised.

A red-spored fungus occurring in spots on the leaves of the Avocado pear causes some damage locally. Practically all of the Avocado pear trees in a district near Joyuda were reported to have died simultaneously. The cause was not determined.

Graphiola phaniceis is well established on the date palms of the island.

Cercospora sp. occurs on Hedionda (*Cassia occidentalis*).

Cercospora personata injures peanuts (*Arachis hypogaea*).

Cercosporium beticola is one of the four or more root rots of the bean.

Colosporium ipomaeae appears in red-brown spots on sweet potato leaves, but it is parasitized by *Ramularia colosporii*, which appears as a white dot in the center of the host colony.

A root rot of the potato (*Solanum tuberosum*) resembles in its effects the "black collar" form of *Rhizoctonia solani*. This fungus seems to preclude the growing of this crop in Porto Rico.

A blight on tomato, which has been under investigation for over a year and which may prove to be *Bacillus solanacearum*, has destroyed many plats in our experiments. Its action is apparently downward through the vascular bundles which enter the petiole. No amount of Bordeaux mixture has any appreciable effect.

REPORT OF J. W. VAN LEENHOFF, COFFEE SPECIALIST.

As stated in last year's report, a beginning was made in January, 1902, with the establishment of coffee seed and nursery beds, the object being the production of select plant material for experimental purposes and for free distribution among coffee planters with whom the station might wish to cooperate. (Pl. XXI.)

As the station had selected, but had not yet been able to secure possession of the desired lands for experimental purposes, these beds were constructed in the immediate neighborhood and on soil which afterwards proved to be very much impoverished. (Pl. XXII, fig. 1.)

Up to the present time, except in a very few instances, coffee planters obtain their seedlings only from plants grown from berries which for different reasons have fallen from the trees and gradually grown up on the same spot, forming in many instances, dense underbrush, making cultivation of parent trees impossible and exhausting the soil to a large extent. As all kinds of berries, from good and bad parent trees, ripe and unripe, sick and healthy, large and small, are to be found among fallen ones and a large percentage of them germinate, the seedlings for this reason alone do not offer a sufficient guaranty to produce healthy and desirable plant material. In fact, the constant use of such material may have produced a degeneration to which the present small crops per acre may be partly attributed. Once the seeds have germinated, they are permitted to grow under dense shade with hardly any light or ventilation, and consequently they become as a rule long, slender weaklings. The roots, grown in uncultivated soil and, because of the crowded condition of the plants, all intermingled, do not have the desirable form of a straight taproot and pyramidal distribution of side roots. Instead of this all kinds of bent forms, knots, and rottenness are general. Several thousands of such seedlings derived from different plantations were inspected, and in many instances not a single one was found with a well-formed root system.

After the germination and the full development of the first leaves in the seed beds, the young plants were transplanted into nursery beds constructed similarly to the seed beds. Before transplanting, 54 of the beds were treated with the following fertilizers: Nitrate of soda, muriate of potash, lime phosphate, bone meal, stable manure, and

Porto Rican bat guano, all applied alone and in different mixtures. The results of these different treatments were that all the beds treated with bat guano or with mixtures of same with other fertilizers gave splendid results, the plants growing twice as fast as those in the other beds. Other manures or fertilizers seemed to have very little or no effect. The bat guano was obtained from deposits in caves, of which a large number exist in the island of Porto Rico.

An analysis of same, as made by the Bureau of Chemistry, United States Department of Agriculture, is given below:

	Per cent.
Total phosphoric acid	12.93
Total potash .....	.96
Total nitrogen (nitrates, present) equivalent to.....	3.32
Ammonia	4.03
Moisture	13.86
Loss on ignition.....	52.33

In October and November all the plants, after they had been gradually uncovered, were standing in the full sunlight, and at the end of November were sufficiently accustomed to the sunlight to be transplanted to the field. Not having yet obtained control of the desired lands, it was decided to leave the plants a year longer in the beds, during which time they developed into fine-looking plants and are now being used for planting in the experimental fields or for supplying planters who are cooperating with the station, the stump-planting system being used.

IMPROVEMENT OF OLD COFFEE GROVE.

As already mentioned in a former report, 10 acres of old coffee lands were divided into 10 square plats of 1 acre each and numbered from 1 to 10. (Pl. XXIII, figs. 1-4.) The crop produced on these plats before any experiments were made was ascertained, with the following results:

Product of 10 acres of Porto Rican coffee in the barrio Anon, district of Ponce, Porto Rico, 1902.

Acre No.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Total.
Ripe berries:											
In liters	1,800	1,516½	2,520	2,659	369	597	378	278	545	523	11,185½
In pounds.....	2,477	1,973	3,115	3,752.5	500	852	529	383	701.5	711	15,295
Coffee ready for market, in pounds.....	545.5	459.5	763.5	805	113	181	114	81	163	158.5	3,387

The harvested berries were measured by almudas to a total of 559.25, for which the pickers were paid 7 cents per almuda, or a total of \$39.15. This quantity produced 3,387 pounds of coffee ready for market, therefore—

- 1 pound berries about equals 0.22 pound ready for market.
- 1 almuda berries about equals 6 pounds ready for market.
- 1 liter berries about equals 0.30 pound ready for market.

The cost per 100 pounds of harvesting and marketing coffee was as follows:

Picking.....	\$1. 16
Pulping, hulling, and drying.....	. 60
Transporting berries from field to factory.....	. 10
Transporting to Ponce market.....	. 25
Total per 100 pounds	2. 11

After the harvesting of the old crop the whole of the 10 acres were carefully weeded and the coffee as well as the shade trees provisionally and roughly pruned, immediately after which operation acres numbered 1, 3, 4, and 8 were selected for making a beginning for the different improvement experiments. For this purpose each of them was divided into 4 square plats of one-quarter of an acre each, making a total of 16 plats, numbered from 1 to 16. The first 4 numbers being of the original acre No. 1, the second of acre No. 3, and so on.

The following operations were then undertaken:

Plat No. 1. Experiments were made with leguminous plants as fertilizer. All vegetation except coffee and shade removed. Coffee, distanced at practically 8 by 8 feet, by removing all trees at less distance. Cowpeas were planted and after they had come up very nicely were plowed under.

Experiment with plant distances.

	Spaced.	Coffee trees.			Spaced.	Coffee trees.	
		Re- moved.	Remain- ing.			Re- moved.	Remain- ing.
	<i>Feet.</i>				<i>Feet.</i>		
Plat No. 1.....	8 by 8	238	130	Plat No. 8.....	7 by 7	107	103
Plat No. 2.....	8 by 8	125	110	Plat No. 9.....	6 by 6	215	207
Plat No. 3.....	7 by 7	63	92	Plat No. 10.....	6 by 6	138	137
Plat No. 6.....	6 by 6	110	113	Plat No. 11.....	7 by 7	110	147

Making a total of 8 plats, or 2 acres, on which were removed 1,106 and remained 1,039 coffee trees. Plats 4, 5, 7, and 12 were left as check plats in their original state.

CUTTING COFFEE TREES TO STUMPS.

On plats Nos. 9 and 10 all existing coffee trees were cut to stumps about 6 inches high, and besides on plat No. 9 all shade trees were removed. Very soon the stump began producing new shoots, in most instances in large quantities. As soon as the shoots had attained a height of a few inches, all of them except two opposite ones were removed from each stump, and since that time the shoots have grown very rapidly, but quicker in No. 9 than in No. 10.

Besides the above-mentioned experiments, all the trees of the first 12 plats were thoroughly cleaned by rubbing with a rough cloth and afterwards painted with lime milk. The general appearance of the trees has improved greatly.



PORTO RICO STATION—LA ISOLINA, A COFFEE PLANTATION.



FIG. 1.—PORTO RICO STATION—COFFEE-SEED BEDS UNDER ARTIFICIAL SHADE.



FIG. 2.—PORTO RICO STATION—COFFEE CROP, 1901. LEAVES REMOVED IN 1900 TO COMBAT LEAF MINER.

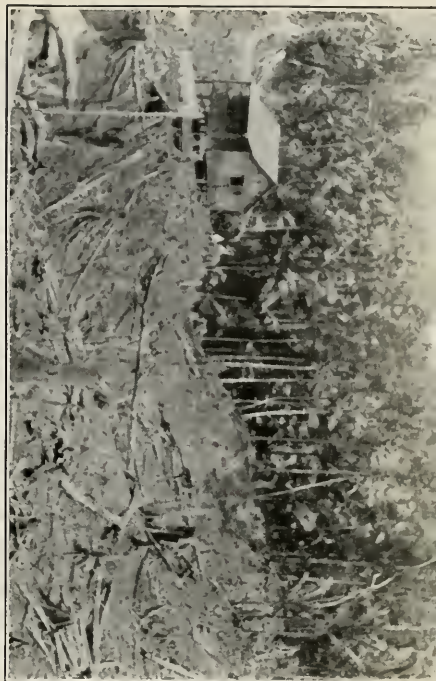


FIG. 1.—PORTO RICO STATION—FOREMAN'S HOUSE AT THE COFFEE EXPERIMENTS



FIG. 3.—PORTO RICO STATION—PREPARING PLANT HOLES FOR COFFEE.

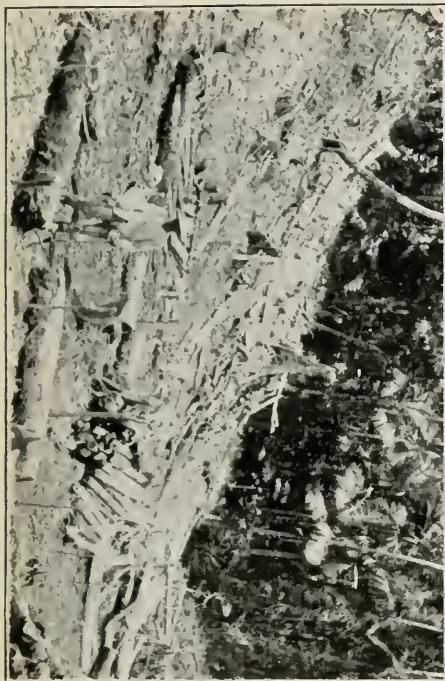


FIG. 2.—PORTO RICO STATION—FELLING THE VIRGIN FOREST.

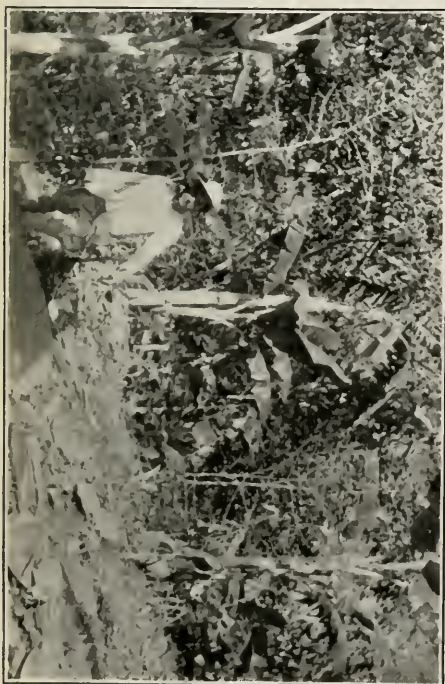


FIG. 4.—PORTO RICO STATION—ORIGINAL CONDITION OF OLD COFFEE PLANTS

RENOVATING OF OLD COFFEE PLANTATION.

Plat No. 13. All coffee and shade removed; plowed, harrowed, and planted to soja beans.

Plat No. 14. All coffee removed, shade left.

Plat No. 15. All coffee and shade removed; plowed, harrowed, and planted to alfalfa.

Plat No. 16. All coffee and shade removed; plowed and harrowed and planted to cowpeas.

The soja beans, after coming up nicely, were damaged by heavy rains, but afterwards recuperated and are now doing fairly well.

The alfalfa was entirely destroyed by heavy rains after having come up nicely.

The cowpeas came up very nicely and grew luxuriantly, and were plowed under before the beans had entirely ripened. After some further preparation the plats will be set to new coffee trees from the nursery beds.

EXPERIMENTS WITH NEW COFFEE.

The object in view is to improve upon the present condition of coffee trees in Porto Rico. Generally speaking this may be done in two different ways—(1) improvements in the Porto Rican coffee and shade trees themselves, and (2) improvements in the Porto Rican coffee by cross breeding, budding, or replacing by foreign coffee and shade trees.

In order to make experiments along these lines possible, a part of the 25 acres of virgin forest mentioned in last annual report has been cleared and a road made through it. Two houses for the foreman and laborers have been built. An imaginary line running north and south through the center of the tract divides it in two parts. To the east of this line experiments are conducted with Porto Rican coffee and shade and to the west with imported varieties of coffee and shade trees.

Seed and nursery beds have been constructed, in which seeds from different sources have been planted. Among these were seven kinds of coffee imported from Brazil, which, however, owing to having been sent in bulk, and, in general, in a very bad and poor condition, did not come up at all. Several kinds from the Hawaiian Islands and Ceylon came up with fine results and have been already planted in the field. Coffee seed from Porto Rico, well prepared, all came up with exceedingly good results. To continue experiments with imported coffee it is desirable to secure as rapidly as possible seeds of a large variety of foreign material, and I would recommend giving the procuring of this material special attention.

Experiments with different plant distances have been begun by planting coffee at distances of 12 by 12, 10 by 10, 8 by 8, 6 by 6, and

4 by 4 feet, and the shade trees, which are representative of Porto Rico, have been planted between them.

COFFEE LEAF MINER.

So much damage is caused by this insect that experiments in exterminating it by collecting and destroying all infested leaves have been tried on several occasions. The first attempt was made at Mammeyes on a patch of old coffee, in which nearly all the leaves were infested. After picking there were so few leaves left that the following crop was very much reduced. The succeeding one, however, was very much better.

The new nursery beds are situated in the virgin forest, a part of which has recently been felled and burned. There is no coffee growing nearer than 1,000 feet of these beds, and they are further sheltered by strips of standing forest which act as wind-breaks. Notwithstanding this isolation, these beds suffered in the beginning of May from an extremely heavy attack of leaf miner. As a remedy all the leaves attacked were continuously cut off and burned. The growth of the plants was retarded considerably, but they recuperated and are now in very fine and healthy condition, without any sign of the leaf miner.

At the station headquarters in Mayaguez the effect of picking the leaves is being tried on an isolated patch of about one acre. The pickings are being made at intervals of about two weeks, and a complete record is kept of the time required and the number of leaves collected at each picking.

The indications are that this method of extermination would prove such a stupendous task that it would be out of the question.

REPORT ON OBSERVATIONS IN PORTO RICO.

By Prof. F. S. EARLE, *of the New York Botanical Garden.*

In accordance with the instructions of the Director of the Office of Experiment Stations, I visited Porto Rico for the purpose of studying its horticultural possibilities and of making observation on plant diseases. Owing to the short time at my disposal, it was impossible to make any extended investigations. The following notes are the result of a brief and hurried inspection of a small portion of the island, and are to be considered as suggestions indicating some lines along which work is needed, rather than as giving results of permanent value.

The horticultural crops now attracting most attention in Porto Rico are oranges and pineapples. Bananas are grown extensively, but mostly in the interior, where difficulties of transportation would prevent their becoming an article of export. Some of the lowlands near the coast are well adapted to the culture of bananas, and there seems no reason

why they could not be grown there profitably for the United States market. At present the subject seems to be receiving no attention. To successfully develop this, or in fact any other branch of the fruit business, better transportation facilities will be necessary. The present steamer service is poorly adapted for the transportation of perishable fruits.

Pineapples thrive in many parts of the island. The finest ones seen were in the neighborhood of Lajas, southeast of Mayaguez. A number of acres are grown here for the Mayaguez and Ponce markets. Some have been shipped to the States, but usually with unsatisfactory results, and the impression prevails that Porto Rican pines do not ship well. This is not remarkable when we remember that they are hauled in bulk often 15 miles in ox carts over a very rough road before being packed for shipment. Under these conditions it would be indeed astonishing if any arrive in good condition. The completion of the railroad now building between Mayaguez and Yauco will make it possible to deliver these at the seaboard in good condition, when their shipping qualities can be fairly tested. There is now a considerable commercial planting of pines in the neighborhood of San Juan. Some shipments from this region are reported as proving satisfactory and as carrying well. I see no reason why the growing of pines should not become a large and profitable industry. A small canning factory has been established at Mayaguez, which, if successful, will lead to a largely increased home market. Pineapples seem very healthy in Porto Rico. No diseases or serious insect pests were observed.

Many thousands of orange trees have been planted during the past two years, and the indications are that these plantings will be largely increased in the near future. The prospects for developing a successful orange industry seem very flattering. There is an abundance of suitable land at reasonable prices. The quality of the fruit is good. Cheap labor, cheap freight rates, and the absence of tariff charges will make it possible to place Porto Rican oranges on the American market in competition with those grown in other countries. The climate is favorable, and so far no diseases or insect pests have been observed that are not to be encountered elsewhere with equal severity. Numerous kinds of scale insects occur, any one of which would be capable of doing great harm, but, as will be shown later, each seems to be held in check by one or more natural enemies. The business is still in its infancy, none of the recently planted groves having reached bearing age, and unforeseen troubles may, of course, develop; but the occurrence of old, healthy, and productive sweet seedling trees in all parts of the island argues well for the future success of the industry. Many other tropical fruits occur in Porto Rico. With the development of transportation facilities, especially when refrigerator transportation can be

secured, some of these may become profitable articles of export. There are, however, many difficulties, aside from those of transportation, in making a profitable market for new and untried fruits, and attempts in this direction should be made cautiously and, at first, on only an experimental scale. A few thrifty grapevines were observed in the neighborhood of Ponce. Judging from observations made in Jamaica, it is probable that some of the European or California varieties (*Vitis vinifera*) will thrive well on the southern or dry side of the island, and that they will ripen their crops well in advance of California, probably during May and June. If this proves to be a fact their cultivation would be profitable, provided adequate transportation facilities could be secured, since the American market is bare of grapes at this season.

NOTES ON DISEASES AND INSECTS.

ORANGES.

Orange scab (*Cladosporium* sp.).^a—This is the only fungus disease of the orange that was observed. It causes wart-like swellings and distortions on the leaves and fruit. It does not often attack sweet oranges, but is usually confined to the sour oranges and the lemon. At present in Porto Rico it is doing no serious damage except to sour-orange seedlings in the nursery. A little more care in locating seed beds and nurseries at some distance from infected sour trees will prevent injury from this disease. It is unwise to plant nursery stock between the rows of orchard trees on account of the danger of the spreading of diseases and scale insects. Spraying with Bordeaux mixture or the ammoniacal solution of copper carbonate will protect trees from injury by scab. Spraying oranges with fungicides should only be resorted to as a last resort, as such sprays will kill the fungus enemies of the scale insects that are mentioned below.

Scale insects.—Four different scale insects were observed on the orange, any one of which would do great damage if allowed to multiply unchecked. Fortunately, a hymenopterous parasite and several fungus parasites are doing much toward destroying them. Judging from the thrifty condition of most of the old seedling trees, it seems reasonable to hope that these natural enemies will in the long run be able to prevent serious damage. The fact remains, however, that many individual trees are now suffering seriously from scale, and planters should provide themselves with the necessary apparatus for spraying these infested trees. It is doubtful if general spraying is either necessary or advisable, since it would tend to destroy the friendly

^aSwingle and Webber, U. S. Dept. Agr., Division of Vegetable Physiology and Pathology Bul. 8, 1896, pp. 20-24.

parasites. In order of abundance, the orange scales observed were as follows:^a

(1) *The purple scale (Mytilaspis citricola)*.—This is probably the most abundant and widely occurring orange scale on the island. When numerous, especially on young trees, it does much harm. Fortunately, it is heavily parasitized by a minute hymenopterous insect and by at least three parasitic fungi. The hymenopter alone must be very effective in keeping down the numbers of the scale, since on many of the trees more than three-fourths of the mature scales were bored by the escaping parasite. Of the fungus parasite, one was the well-known red-scale fungus, *Sphaerostilbe coccophila*. This occurs somewhat widely, but at the time of my visit, the close of the dry season, it was nowhere abundant. It probably spreads rapidly with the beginning of the rains, and is doubtless a factor of importance in keeping down this and other scales. This fungus can be easily cultivated in the laboratory,^b and in moist weather the cultures mixed with water can be successfully used as a spray for introducing the fungus on trees where it does not occur naturally. Another widely occurring fungus forms a black coating over the scales. The individual black masses are small and rounded, 1 to 2 millimeters in diameter, but they are crowded together and often somewhat confluent over considerable areas when the scales are abundant enough to form an incrustation. At first these black masses are sessile, but at length some of them are more or less stalked and become quite hard. In most of the material secured no spores are present and the systematic position of the fungus remains in doubt. There can be no question of its parasitic nature, since at first it is confined exclusively to the scales and can be lifted away with them. The fungus seems to grow rather slowly, but when the scales are abundant it eventually destroys them over large areas. The trunks and limbs of many of the old trees on the island are blackened by the remains of this fungus. Some crude attempts at securing artificial cultures were made, but so far without success. What was probably this same black fungus was sent to the writer some years ago by Prof. W. M. Scott, State entomologist of Georgia, on San José scale from the southern part of that State.^c There is a fragment of what seems to be the same fungus in the Ellis herbarium on orange twigs from Umatilla, Fla., collected by C. A. Hopkins, and sent to Mr. Ellis by Miss E. A. Southworth, then of the United States Department of Agriculture. The specimen is accompanied by notes and drawings by

^a For the determination of these scales and much other assistance I am indebted to Prof. O. W. Barrett, entomologist of the Porto Rico Experiment Station.

^b Rolfs, Florida Sta. Bul. 41, 1897, pp. 527-531.

^c Professor Scott published an account of the good work done by this fungus in destroying the San José scale in Proc. Georgia State Hort. Soc., 22 (1898), pp. 69, 70.

Miss Southworth, and it was determined by Mr. Ellis as *Myriangium duriei*, and is so reported by him,^a but with the following note: "The measurements of asci and sporidia are from the Florida specimens; those from more northern localities have the sporidia mostly smaller. The Florida specimens also differ from those found in the northern States in the absence of any free margined, thalloid, effigurate subiculum."

In this specimen the fungus is situated on and among a mass of the same purple scale, though this is not noted by either Mr. Ellis or Miss Southworth. This is clearly a *Myriangium*, since the peculiar cellular stromatic masses have numerous ascigeral cavities, each containing a single suborbicular ascus, with muriform, hyaline spores. The asci and spores certainly closely resemble those of *M. curtisii*, which is usually regarded as a synonym of *M. duriei*, and is a frequently occurring bark parasite on various trees and shrubs in the southern States; but besides the lack of a sterile effigurate subiculum, as noted by Mr. Ellis, the stromatic masses are flattened or slightly curved and not somewhat cup-shaped, as is usual in *M. curtisii*. One small piece of the Porto Rico material shows asci and spores that agree perfectly with this Florida specimen. The others noted above are sterile and of a harder consistency, although the young stages look exactly like the ascus-bearing specimen. The further study of more abundant material will be necessary for a full understanding of this interesting species.

The white fungus, described below under *Lecanium*, was occasionally found on the purple scale, but only when it had crept over from neighboring infected individuals of the *Lecanium*. It does not seem to be primarily a parasite of the purple scale.

(2) *The chaffy scale (Diaspis pentagona)*.—This occurs very commonly on the orange, as well as on various other trees and plants. It is attacked to some extent by the black fungus mentioned above, but no other parasite was observed on it. On account of this lack of enemies it seems to be increasing more rapidly than either of the other orange scales and is, perhaps, more likely than any of the others to become seriously troublesome.

(3) *The "ant cow" (Lecanium hemisphaericum)*.—This well-known greenhouse pest occurs on the orange in Porto Rico, usually attacking the young succulent twigs. It is heavily parasitized by a minute, white mold-like fungus^b (*Sporotrichum* (?) sp.) that is first seen protruding from under the margin of the scale, but it soon completely envelops and destroys it. The fungus produces immense numbers of exceedingly minute conidia that serve for its rapid propagation.

^aNorth American Pyrenomycetes, 1892, p. 621.

^bThis fungus parasite occurs in Grenada and Barbados. See Scale Insects of the West Indies. H. Maxwell-Lefroy, West Indian Bul. 3, 1902, p. 314.

These are doubtless scattered to some extent by the wind, but it seems probable that they are more often inadvertently carried from the diseased to healthy scale by the small ants that always accompany this scale and can be seen running about among them in great numbers. With the beginning of the rainy season the fungus was multiplying with great rapidity and seemed abundantly able to hold the scale effectively in check. In fact on many trees it had already been completely exterminated.^a

(4) *The red scale (Aspidiotus ficus)*.—This scale was observed in several localities, but nowhere abundant enough to do much harm. It infests both the leaves and twigs. It is occasionally parasitized by the white fungus mentioned above, but not to the same extent as the Lecanium.

Other orange insects.—Two species of beetles belonging to the Curculionide were observed feeding on orange foliage. They are of about the same size (1 centimeter long), one being brown in color, the other light green. The green one was much the more abundant, and in some cases was seriously injuring the foliage. Whether, like the related *Præpodes* in Jamaica,^b the larval stage fed upon the orange roots was not determined. It would doubtless be practicable to protect the trees from this injury by spraying with Paris green.

A large brown beetle (*Lachnosterna* sp.), closely resembling the May beetle, was abundant in the orange groves. Round holes, a centimeter or more in diameter, were often observed in the ground near the base of the trees. On digging down one or more pairs of these insects were always found. They did not seem to be feeding on the roots, and whether they were there for oviposition or only for shelter could not be determined. At night they emerge and fly about freely. The larva is probably a "white grub" feeding on plant roots, but whether particularly on orange roots is doubtful.

One species of small black ant occasionally does damage by gnawing the bark of young trees both below and above the surface of the ground. In some cases trees have been girdled and killed by them. The ants build little runways covered with particles of earth cemented together on the trunks of the trees where they are feeding, so that it is comparatively easy to find those trees that are being attacked. Some planters claim good results from brushing off these runways and applying a ring of coal tar to the base of the tree. As coal tar is often dangerous when applied to the bark of young trees, it was suggested to substitute a rosin mixture like a thin, sticky grafting wax, to be applied with a brush. This would cover and promote the healing of

^aSince my return to New York I have found the same fungus on the scale in the greenhouse of the New York Botanical Garden.

^bJour. N. Y. Bot. Gard., 4 (1903), p. 8.

injured places and would probably prevent further attacks. These ants do not seem to live in large burrows or "ant hills," so it is difficult to destroy them with carbon bisulphid.

COFFEE.

Coffee has long been the leading agricultural crop of Porto Rico. A large part of the hill lands of the interior are probably better adapted to coffee than to any other commercial product. Owing to discouragement over the losses caused by the disastrous hurricane of 1899 and to the continued low prices, many of the estates are being greatly neglected and the production has fallen far below what it should be from so large an acreage. On only too many of the estates weeds and bushes are allowed to grow among the coffee unchecked, and the bananas, originally planted for shade, have multiplied through neglect until the coffee is being smothered. In many cases the trees were too closely planted in the first place and, with this overshadowing and no attempt at pruning or training, they have spindled up into slender, feeble bushes that are utterly unable to bear a satisfactory crop. Evidently, the greatest need of the coffee industry is for a reform in cultural methods. While coffee may require a certain amount of shade for its best development, it is certainly true that overshadowing and neglect are disastrous. Experiments to determine the proper amount of shade, the best kind of shade trees, the best distance for planting, and many other practical cultural questions are being undertaken by the Porto Rico Experiment Station at its substation on the Carmelita estate in the hills north of Ponce. Under the able supervision of Mr. Van Leenhoff, the coffee expert of the station, results of great practical value may be expected. While neglect in consequence of low prices is perhaps natural, it should be remembered that in any industry during periods of depression those producers are best able to survive who, by employing the best methods, are able to increase the total output without proportionally increasing the expense. Thus in the Southern States, during the years when 5 cents or less was the ruling price for cotton, those planters who by good management were able to produce a bale to the acre could still come out even, or perhaps make a small profit, while those who only produced a third of a bale per acre were plunged hopelessly into debt. It is the same with coffee. Those who neglect their estates during the present crisis will inevitably be forced out of the business, while for those who by industry and skill succeed in producing maximum crops there is still a reasonable profit even at present prices.

Coffee leaf miner (Leucoptera coffecella).—This insect seems to be the most serious coffee pest in Porto Rico. It is a minute silvery moth. The damage is done in the larval stage when it burrows within the

leaf tissues, causing the death of irregular areas 1 to 2 centimeters in diameter. When several of these dead areas occur on each leaf, as is often the case, the reduction of active leaf surface is so great as to seriously derange the nutrition of the plant. No natural enemies of this pest were observed. The larvæ are so protected, owing to their feeding on the inner tissues of the leaf, that applications of insecticides would be useless. The only possible remedy that suggests itself is the laborious one of hand picking and burning the infested leaves. At first thought this would seem impracticable with a crop like coffee on account of the expense. It is probable, however, that thorough work continued for a single season would so nearly exterminate the pest as to give practical immunity for a number of years. If so, the expense would be amply repaid by the increased yields of successive crops. The mature insect is so small that it is not likely that it flies far, and an estate once thoroughly cleaned up would be only slowly reinfested. This method of treatment is at least promising enough to deserve a practical test. A thorough study of the habits of the adult moth might suggest some means by which the insect could be more cheaply combated while in this stage, but in the absence of this knowledge no plan of attack can be suggested. The injury done by this insect is serious enough to demand a thorough investigation of its habits and life history.

Stilbum leaf spot (Stilbum flavidum).—In moister locations, and especially where overshadowed, coffee leaves are also much spotted by this fungus. The *Stilbum* spots can easily be distinguished from those caused by the leaf miner by their lighter, nearly white color and regularly rounded outline. They are usually about 1 centimeter in diameter. The leaf miner spots are brown and irregular in outline. At certain times the fruiting bodies of the fungus can be seen with the naked eye abundantly scattered over the spots. They consist of minute, pale, yellow stalks, 2 to 3 millimeters high, ending in a small enlargement or knob. While the *Stilbum* disease is rather troublesome under present conditions it is not to be specially feared, since it only occurs where there is too much shade and moisture. It can be completely controlled by a proper thinning of the plantations and the cutting out of excessive shade.

Sclerotium (?) leaf blight.—A peculiar disease of coffee foliage was observed at one spot on the Carmelita estate. The above name is provisionally suggested for it, although no true *Sclerotia* were found. The underside of the leaves were covered by a thin web of delicate white mycelium. On the petioles and twigs this mycelium was gathered into thick, tough brownish strands that advanced rapidly up the stems, spreading out again into a delicate white web as each leaf was reached. No spore forms were observed, the fungus having the appearance of the mycelium of some of the hymenomycetes. The

infected leaves soon blackened and after a time dropped. No trees had been entirely killed by it, but all within the infected area (something less than an acre) were badly injured. It seems to be spreading rapidly in concentric circles, and it was strongly advised that all the infected trees be cut down and burned. The disease was not observed at any other point, and it is hoped that it is not widely distributed. If it should ever become prevalent it could doubtless be held in check by spraying with Bordeaux mixture, but for occasional sporadic outbreaks the cutting and burning of infected trees seems better and safer. The name given above was suggested by the close resemblance of this disease to one that occurs quite frequently on pear and other fruit trees in southern Georgia, Alabama, and northern Florida. During the season of midsummer rains this fungus spreads out over the twigs and foliage much as with this coffee fungus, but during the winter it assumes the form of brown sclerotium-like masses on the older twigs. The rainy season had begun when the coffee fungus was seen in Porto Rico. Whether it forms *Sclerotia* during the dry season or simply exists in the form of the thick brown strands noted above could not be determined.

Coffee root rot.—On one estate in the hills east of Mayaguez a serious root disease of coffee was observed. The roots are gradually killed by the growth of the delicate white mycelium of what is probably some hymenomycetous fungus. This spreads slowly underground from tree to tree. Unfortunately, the "guaba," one of the leguminous trees most widely planted as a coffee shade, is attacked by the same disease. In fact, it seems more susceptible than the coffee, since the diseased areas often seem to start from a dead or dying "guaba" tree as a center. Root diseases of this class are very difficult to combat. It may be necessary to entirely abandon the cultivation of coffee on badly infested areas. If so, it becomes a matter of prime importance to know what alternate crop could be safely planted on such infested lands. Where the disease is confined to certain small, well-defined areas it can be kept from spreading by digging and keeping open a deep trench around the infested areas, going deep enough to get well below the lateral spread of the roots. All trees within the area should be dug up and burned and no others planted for a period of years, since such fungi are usually very persistent, living on the dead roots, etc., in the soil. The disease was only observed in this one locality, but reports from various parties indicate that it is somewhat widely scattered.

Mealy bug at the root.—On examining the roots of certain feeble-looking trees they were found to be infested by some species of mealy bug. Lack of time prevented a sufficiently thorough investigation to determine whether such cases are abundant enough to cause material

damage. The trees in question had been stunted by overshadowing and neglect. It is doubtful if this trouble will prove a serious one where trees are in a condition of vigorous growth.

Leaf-eating insects.—A small gray beetle belonging to the Curculionidae is doing much harm by gnawing the expanding terminal buds on the young twigs. As the leaf tissue gets older and harder it does not seem to be attacked. On some trees almost every bud had been gnawed and the young shoots very much injured. A few other unimportant leaf-eating insects were observed. Spraying with Paris green is the indicated remedy in those cases where the damage is sufficient to justify the expense.

Black aphid.—The young twigs of coffee are at times badly infested by a large black aphid (species not determined). At the time of my visit these were comparatively scarce and almost every individual seen showed evidence of being parasitized, probably by some hymenopterous insect.

Coffee scale (Lecanium sp.).—A large brown *Lecanium* (probably *L. hemisphericum*) is also at times abundant and destructive, attacking the young growth and also the berries and peduncles. At the time of my visit but little of this scale could be found and that was heavily parasitized by the same white fungus (*Sporotrichum*?) mentioned above as attacking this scale on the orange. This fungus is so effective in destroying the *Lecanium* that it is to be hoped some way may be found for successfully cultivating it in the laboratory, so that it can be artificially introduced when natural infection fails to occur.

SUGAR CANE.

Next to coffee this is the most important commercial crop of the island. Owing to lack of time, it was impossible to make more than a casual investigation of this crop, and only one disease was noted. On the beautifully lying level coast lands, where cane is mostly cultivated, it would seem to be entirely practicable to use horse machinery in preparing and ditching the land and in cultivating the crop to a much greater extent than is now practical. The present excessive dependence on hand labor greatly increases the cost of production.

Sugar-cane root rot.—On entering Ponce by rail from Yauco considerable areas in certain fields were noted from the car windows where the young ratoon canes were very pale in color, in fact, almost milk white, and whose growth was very feeble. On visiting these fields the old stubble and the base of the young canes was found to be enveloped in a mass of the white mycelium of some hymenomycetous fungus. No fruit bodies of the fungus were found on the stubble or on living canes, but on some pieces of old cane lying on the ground well-developed specimens of a peculiar white *Schizophyllum* were found. The

disease resembles closely the Marasmius cane disease of Barbados,^a and some of the other islands. It is possible that it will prove to be this disease, but the symptoms are slightly different, and no fruit bodies of the Marasmius could be found. *Schizophyllum lobatum* is known as a wound parasite in Java,^b so it seems possible that the Schizophyllum found on the old canes may be connected with this root trouble, but no direct evidence of such a connection was secured. Laborers were at work digging out the dead and dying hills with hoes and replanting them. This will doubtless prove to be a waste of labor as the soil is so well stocked with the fungus that the new cuttings will soon contract the disease. Such areas should be at once plowed up and not replanted to cane for a term of years. So far as observed the disease was mostly confined to certain areas of poor, white, rocky soil, and it was only seen in this one locality. It is hoped that it will prove to be only a local outbreak. The soil on which it was found was poorly suited to cane in the first place and ought not to have been planted to this crop.

TOBACCO.

Tobacco is an important crop in Porto Rico. The quality of the leaf grown in the open is good, and recent experiments show that under cheese-cloth tents a wrapper leaf of the finest quality can be produced. It was offseason at the time of my visit, so that the only plants seen were those that had produced the regular crop and one ratoon or sucker crop that had been harvested and were now growing a second sucker crop that was being allowed to run up to seed. The indiscriminate saving of seed from such old and exhausted plants can hardly be a wise practice.

Tobacco wilt.—In one small field in a sandy river bottom near Ponce, a portion of these old plants were seen to be dying from some wilt disease. On pulling up the freshly wilted plants one or more of the fibrous roots were found to be brown and partially rotted, while the browning had extended up in irregular patches on the main root or crown until this had been girdled. In some cases this browning extended up to the surface of the soil. The disease seemed to involve the bark and cambium layer, but did not at first penetrate to the hard, central, woody tissues and did not discolor the vascular bundles. No fungus was observed on the freshly killed tissues. An agar tube inoculated on the spot with a fragment of the discolored tissue of the cambium layer has developed an abundant growth of bacteria, but no fungi. It has not been possible to make further studies of this disease. It should be carefully investigated, as it shows characteristics that might make it dangerous.

^a See A. Howard, Diseases of Sugar Cane in the West Indies, *Annals of Botany*, 17 (1903), pp. 391–413.

^b Raciborski. See a review in *Centbl. Bakt. u. Par.*, 2. Abt., 5 (1899), p. 169.

COTTON.

Cotton culture is beginning to attract some attention in Porto Rico. I saw no fields of cotton, but scattered plants of the perennial *Gossypium barbadense* were not uncommon along the roadsides. These thrive so well under conditions of absolute neglect that there can be no doubt as to the success of this crop when properly cultivated. Two leaf diseases were noted.

The true cotton rust.—The true cotton rust (*Uredo gossypii*) was collected on some of these wild plants near Mayaguez. It has heretofore only been reported from Ecuador. It causes small purplish-brown spots on the leaves and would probably cause them to fall prematurely. It is not, however, likely to prove particularly troublesome. It is entirely distinct from any of the diseases that have been called "cotton rust" in the United States.

Cotton arcuate mildew.—This well-known disease of the Southern States, caused by *Ramularia arcuata*, also occurs on leaves of the wild cotton near Mayaguez. It produces white, frosted patches on the underside of the leaves. It is a disease of secondary importance, mostly occurring only on rank plants in moist places and doing but little harm.

COCOANUTS.

Cocoanuts are widely planted in Porto Rico. For the most part they seem quite healthy. No trace of either of the serious diseases found in Jamaica^a was observed. In the neighborhood of Ponce many of the trees were yellow and some were dying. Inspection showed that the trouble was caused by scale insects. Fortunately, a lepidopterous larva was present in some numbers feeding on the scales. Specimens were secured by Professor Barrett, and it is to be hoped he will succeed in rearing them. Unless this or some other enemy of the scale multiplies very rapidly, a number of trees in the neighborhood of Ponce will be lost, as they are very badly infested.

CACAO.

This crop has so far attracted but little attention in Porto Rico. There are, however, some plantations and others are contemplated. Only a few opportunities for observing this crop were found, and but two diseases were noted. Some complaint was heard of losses of trees from root rot, but no cases were seen.

Cacao die back.—Certain trees that were growing in dry exposed places were gradually dying back from the tips of the branches. The appearance was something the same as where trees are suffering from

^aSee Report on a trip to Jamaica, Jour. New York Bot. Gard., 4 (1903), pp. 4-7.

some root trouble, but in these cases the roots were normal. The bark on the upper more exposed side of the twigs and branches was seen to be brown and diseased for some distance in advance of the death of the leaves. Some small pustules were observed on this diseased area containing rather immature pycnidia with large oval, continuous, colorless sporules. In this condition the fungus would be classed as a *Macrophoma*, but its appearance suggested that at full maturity the sporules would probably become brown, when they would be classed in *Sphaeropsis*; or, if the spore became divided into two cells, in *Diplodia*. The sporules in the latter genus often remain for some time in this colorless condition before dividing and turning brown. A similar dying back of cacao limbs occurs in Grenada,^a caused by *Diplodia cacaoicola*, P. Henn.^b It seems probable that the Porto Rican fungus will prove to be this species, but unfortunately the material secured does not fully settle the question.

Cacao pod rot.—The same pod rot noted in Jamaica^c occurs in Porto Rico. It usually attacks the blossom end first, finally involving the entire pod. The tissues turn brown and are somewhat softened, and the surface is soon covered by a white mold-like growth. This consists of delicate filament bearing great numbers of very minute oval spores. In agar cultures larger oblong septate spores are produced, showing that it is probably some species of *Fusarium*, though the spores are straight, not curved as is usual in this genus. Three rots of cacao pods have been described from the West Indies,^d but this is clearly different from either of them. It promises to be quite destructive, especially during wet weather and where trees are overshadowed.

PAPAW.

The papaw (*Carica papaya*) is a conspicuous tropical fruit and one that seems to have some commercial possibilities. The tree comes into bearing when less than a year old and produces enormous crops. The ripe fruits, which are about the size and shape of a muskmelon, have a very sweet, rich flesh that is liked by many people. With refrigeration they could doubtless be transported successfully to northern markets, where they would in time win a recognized place. The green fruits are boiled and used as a vegetable. Recently some interest has been attracted to this crop by its use for the manufacture of a

^aThe Fungoid Diseases of Cacao in the West Indies, Albert Howard, West Indian Bul. 2 (1901), pp. 203-205.

^bFor a further discussion of this fungus see *Diplodia cacaoicola*, P. Henn, a parasitic fungus of sugar cane and cacao in the West Indies, Albert Howard, Ann. of Bot., 15 (1901), pp. 683-701.

^cJour. New York Bot. Gard., 4 (1903), p. 9.

^dSee Mr. Howard's paper on Cacao Diseases, referred to above.

digestive agent that it is claimed is equal to or superior to animal pepsin. Unfortunately, the plant seems rather subject to diseases. Besides the two troubles mentioned below, it is attacked and injured by red spiders during the dry season, and Professor Barrett has observed a bud rot that kills the plant by destroying the terminal bud and the soft tissue at the apex of the stem. No cases of this disease were observed.

Papaw scale.—A scale insect, probably *Diaspis pentagona*, attacks the papaw very seriously and is killing a great many of the trees. No parasites were observed, and spraying will have to be resorted to to save the trees. So far as I know nothing is known as to the resistance of papaw foliage to kerosene or other insecticides, and experiments would have to be made to determine what treatment would be safest and most effective.

Papaw leaf blight.—A fungus (*Pucciniopsis caricæ*)^a was observed in the neighborhood of San Juan. It forms small (1 millimeter) erumpent black masses on the under side of the leaves and causes more or less yellowing of the surrounding tissues. The attacked leaves fall prematurely. It seems more abundant on young seedlings, but was also observed on bearing trees. The damage done by it is usually of minor importance, but when combined with the attacks of the scale it hastens the death of the trees. Spraying with Bordeaux mixture is the indicated remedy.

BEANS AND COWPEAS.

Beans are extensively grown in Porto Rico and constitute an important element in the food supply. The common bean rust (*Uromyces*) was observed, and a few cases of two wilt diseases were found. Still a third wilt occurs on the cowpea. Neither of these wilts seemed to be caused by *Neocosmospora*, the common wilt fungus of the Southern States. They have not been sufficiently studied for further comment at this time. As they are probably of considerable economic importance, they should be fully investigated.

Doubtless many other diseases of economic plants occur that were not observed during the short time at my disposal. On the whole, the more important crops do not seem to be unusually subject to serious diseases. In fact, their production is less heavily handicapped in this way than in many competing countries; still enough is recorded above to indicate the need for a careful study of the diseases that do occur. The diseases of tropical plants have received comparatively little attention and the field is a wide and important one, since tropical products seem destined to play an ever-increasing part in the world's commerce.

^a Bul. New York Bot. Gard., 2 (1902), p. 340. Described specimens sent from Sanibel Island, Florida, by S. M. Tracy.

In this connection attention should be called to the fact that so far Porto Rico has no legal protection against the introduction of injurious insects and diseases. The increased interest in the growth of horticultural products is certain to lead to the introduction of many new species and varieties of plants. It is by the introduction of infested plants that dangerous insects and diseases are usually disseminated. All of the more important horticultural States have found it necessary to protect their interests by providing for the inspection of nursery stock of all kinds. It would be wise for Porto Rico to follow their example and provide for the efficient inspection of all imported plants.

REVIEW OF IRRIGATION INVESTIGATIONS FOR 1903.

By ELWOOD MEAD, *Chief of Irrigation Investigations.*

The following is a résumé of the investigations in irrigation and drainage carried on by this Office during the past season in both the arid and humid portions of the United States and a two-months' study of irrigation in northern Italy made by the writer. A complete report of the work in some of the States can not be given at this writing, because the computations and tabulations necessary thereto have not been completed. The special studies in irrigation carried on in the different States will be described separately.

CALIFORNIA.

S. FORTIER, Director Montana Experiment Station, in charge.

In 1903 the legislature of California appropriated \$10,000 to aid this Office in its investigations in California during the fiscal years 1904 and 1905. The agreement for this cooperation provides that each party shall contribute equally to the expenses, and that the work in 1904 shall include studies of the duty of water in irrigation and the factors which influence it; studies of the methods of irrigation employed in California, with a view to securing the adoption of better methods than those now in common use; studies of loss of water from canals and flumes through seepage and evaporation and the best means of alleviating the injuries caused, either by improving the construction of canals or removing surplus water by drainage; studies of the methods and cost of pumping water.

The climate of California permits of the production of special crops, such as citrus fruits, grapes, and sugar beets, which have a high acreage value, and which have raised the prices of land and water in California above those of any other State. This intensive agriculture, however, occupies but a small part of the irrigated district. Over 4,000,000 acres of fertile lands are now seeded to wheat and barley, and about 2,000,000 acres in adjacent fields are unproductive summer fallow. The average annual return from this vast acreage of unirrigated land, including the area summer fallowed, is probably not over \$7 an acre.

In some of the districts where citrus fruits are grown the high price of land and water has extended the area irrigated until the adoption of the most skillful and economical methods is necessary in order to

serve all the land now being watered. This makes it necessary to determine the methods by which water can be applied to crops with the least waste and least loss.

Opinions differ among fruit growers in California as to the kind of furrow to use in orchard irrigation. Ten years ago the shallow furrow was generally adopted, but the practice in recent years has been toward a less number of deep furrows. The chief reason for this change is the saving of water due to diminished evaporation. Six months ago there was no definite information available as to the difference in evaporation between the two modes of application. Since July last the experiments carried on by this Office in comparing the losses due to evaporation in shallow and deep furrow irrigation show that when water was applied to the surface of bare soil 93 per cent was lost by evaporation. When the same quantity was applied in shallow furrows 3 inches deep the loss was 83 per cent. When applied in furrows 12 inches deep the loss was only 62 per cent.

In California it costs from \$5 to \$15 per acre to prepare land for irrigated crops. The profits from a given acreage will depend in no small degree on the adoption of a suitable method and the manner of preparing the surface and the ditches in accordance with that method. In order to determine which practice is best suited to a particular crop and furnish irrigators with reliable information on this branch of the subject, a careful study is being made of the different ways in which water is used. The field of inquiry has included the furrow, basin, and check systems of irrigation as well as the various means used to distribute water in shallow and deep furrows.

Experiments have been carried on during the past six months with the object of determining the effect of irrigation on the worn-out fields of the San Joaquin and Sacramento valleys. Cereal and forage crops are being grown in basins made of galvanized iron and the quantity of water added to the typical soils contained in these vessels varies from nothing to 24 inches in depth over the surface. In so far as practicable, natural conditions are maintained and the yield in each receptacle will be compared with the amount of water applied. It is hoped that, if the crops watered show a marked increase in yield, it will tend to induce agriculturists to extend the irrigated area over regions that are now being cultivated by the aid of rainfall alone.

In recent years the most pronounced extension of irrigation in California has been due to the use of pumps to provide a water supply. The abundance and low price of petroleum and the utilization of the power of streams to generate electricity have been two important contributing causes to this. At the present time crude petroleum costs about 2 cents a gallon. It seems possible that with better transportation facilities the price may be reduced to one-half of this. With such cheap fuel it will be possible for farmers to cooperate in the

building of large central power plants for the generation of electrical energy by the consumption of crude oil. This energy can be distributed to motors on the respective farms of the shareholders and enable water to be lifted from wells 25 feet deep at a cost of \$1 per acre-foot. It seems reasonable to conclude that cheap fuel, together with the utilization of the fall of the mountain streams, will produce cheap power, and that cheap power will tend to increase at a rapid rate the number of pumping plants. This branch of the investigation in California is being carried on as follows:

(1) Collecting descriptions of all existing plants and tabulating the results.

(2) Making field tests of plants in operation.

(3) Measuring the amount of water discharged by different plants and ascertaining the average duty of water under pumping plants.

(4) Making laboratory tests to determine the efficiency of various makes of pumps and engines.

NEVADA.

GORDON H. TRUE, Professor of Animal Husbandry, Nevada State University, in charge.

The legislature of Nevada appropriated \$2,000 to aid in cooperative investigations between this Office and the State agricultural experiment station. A plan for cooperative studies of the duty of water and the best means of preventing or removing the evils caused by seepage water by drainage was prepared by this Office and submitted to the governor. Consideration of this was delayed until after the time for beginning such studies, and the only investigations carried on this season in Nevada have been made at the State experiment station.

These have embraced measurements of the duty of water and determinations of the losses from seepage and evaporation in ditches, which are carried on under the direction of Professor True. In addition to these Professor True has made two reports, one on the methods of preparing land for irrigation, and one on certain types of current wheels in use in Nevada. These reports are a part of a general cooperative investigation carried on under the direction of this Office, to be referred to hereafter.

OREGON.

JAMES WITHEYCOMBE, Director Oregon Experiment Station, in charge.

The irrigation problems of Oregon are of an exceptional character. The western and most populous part of the State is humid. To more than three-fourths of the people irrigation is a matter having no direct interest, and its development in the arid sections has been neglected. In the eastern and central portions of the State are large areas, esti-

mated by Professor Withycombe to include 3,000,000 acres of land, in which agriculture is on the border line between ability to grow crops without irrigation and failure in attempting to do so. There are other large areas having ample water supply, but where the climatic conditions are not as yet understood. It is therefore one of the most attractive and at the same time most difficult fields for the conduct of the studies intrusted to this Office.

At a conference held in Portland, Oreg., under the auspices of the chamber of commerce of that place and attended by the director and board of trustees of the State experiment station, it was agreed that the study of the best means of utilizing small quantities of water and a determination of the best means of applying it to crops would be a work of great practical value in the agricultural development of the State. For this purpose special apparatus has been designed by this investigation and installed by Professor Withycombe, by means of which measurements of different quantities of water applied in irrigation are being made.

At Umatilla 6 tanks 20 inches in diameter and 3 feet deep have been installed. They are filled with soil in such a way as to reproduce natural conditions—that is, in the bottom is placed 13 inches of gravel and sand mixed, and above this 18 inches of volcanic ash and sand mixed, which is the character of the surface soil in that locality. These tanks were filled and weighed, and then water to 15 per cent of the weight of the soil was supplied to each tank. Nos. 5 and 6 were planted to soy beans, Nos. 3 and 4 to barley, and Nos. 1 and 2 are fallowed. One of these tanks will be cultivated—that is, the soil will be stirred similarly to cultivating, and in the other it will remain without stirring. These tanks will be weighed about every fifteen days and water supplied to bring them up to their original weight, so that the exact loss of water from the different tanks can be ascertained.

Alongside of these tanks in the same inclosure are 5 plats 3 by 6 feet each. They are separated by means of sheet zinc embedded into the ground 3 feet deep, so as to reduce the liability of the water percolating, laterally, from one plat to another. These plats are supplied with equal amounts of water, namely, 15 per cent by volume, except No. 4. This is subirrigated by means of an iron pipe placed 18 inches below the surface and running about 4 feet through the middle of the plat, and just one-half the water was supplied to this plat that was supplied to the others. Plat No. 5 is planted with soy beans, plats Nos. 3 and 4 are planted with barley, and the other two are fallowed to be treated similarly to the fallowed tanks. Samples of soil taken from these plats have been forwarded to the chemical laboratory of the Oregon State Experiment Station for moisture determinations at the same time the tanks are weighed.

The climatic conditions of different sections of the State are being

studied for the purpose of selecting localities for experiments to determine the benefits of irrigation, which will fill the subsoil with moisture, will furnish an effective supplement to the rainfall of the succeeding summer, and thus add to the certainty and amount of yields obtained.

WASHINGTON.

O. L. WALLER, Professor of Irrigation Engineering, Washington Agricultural Experiment Station, in charge.

The most important irrigated district in Washington is the Yakima Valley. Here the large yields of grain, alfalfa, and fruit have given land and water an exceptional value, and have led to a rapid extension of the irrigated area during the past five years. This increased demand on the stream is making imperative better arrangements for the division of water between ditches and its more economical use by farmers.

In addition to the extension of irrigation under ditches already built, the construction of a number of other large works is either under way or the preliminary arrangements are far advanced. A canal 41 miles long is being built near Ellensburg; the Indian Bureau of the United States Government is building a canal to water 20,000 acres near Yakima; the Sunnyside Canal is being extended to bring several thousand acres of land under irrigation; and a high-line canal, estimated to cost \$3,000,000, is being surveyed. Estimates are being prepared for the construction of storage reservoirs, and the complete utilization of this river in the near future is assured.

The measurements of acreage irrigated made by this Office show that an area of 110,000 acres of land is now being irrigated and that there is under ditches already constructed an additional area of 130,000 acres which can be irrigated. This makes a total of 240,000 acres which can be supplied when the present ditches have been enlarged and put in better condition. To this can be added a large area of land along the Columbia River. Near Mabton many thousand acres can be supplied from the Indian canal, if it can be extended in that direction. To furnish the water for this land the natural flow of the river can be supplemented by storage. Several natural lakes with a combined capacity of 240,000 acre-feet can be utilized for this purpose with a duty of 110 acres for each cubic foot of water per second. This stream will serve 300,000 acres of land, but with the duty shown in some of the measurements made by this Office, where enough water was applied to the land in a single season to cover it to a depth of 10 feet, it will not serve one-third of that area. The work of this Office is to promote the adoption of methods needed to secure the higher duty.

At the present time there are no administrative regulations to protect the rights of the different appropriators or to insure economy in

the use of water. These will be indispensable in the near future, and the aid of this Office in the gathering of facts needed in preparing these regulations was invoked. As a basis, knowledge of two conditions is indispensable. One is the amount of water now being diverted and the other is the amount which returns as seepage. Through the cooperation of the different ditch owners, Professor Waller and his assistants have been enabled this summer to obtain complete measurements of the volume of water taken from the stream by the different canals. Comparing this with the records of the stream's discharge gives an approximate idea of the percentage which returns as seepage and the manner in which this affects the available water supply. Incidentally, it gives the data for determining the average duty of water throughout this entire district—one of the essential facts greatly needed by courts, canal companies, and farmers in organizing the distribution of water over large areas.

Professor Waller reports that this work began on June 20, and that from this time until August 1 he and his assistant were kept busily employed in installing gauge rods, measuring the flow of water in the canals, and gathering data to show the acreage irrigated. He reports that everybody in this valley is interested in the work being done, and that there are urgent requests for information regarding the results; that some of the parties connected with the large projects are anxious to know whether there is any water for them before undertaking the expenditure of large sums of money in ditches or flumes.

These investigations, to be reliable, must be continued through another season. The immense amount of preliminary work imposed upon Professor Waller delayed some of the records, so that another season will be necessary to get a complete record. He proposes to put a man in the field early in March in order that he may get over the entire section before water is turned into the ditches, check the gauge rods and canal sections, and determine the conditions regarding depth of soil water where seepage is an important factor. The practical value of this work, both to those engaged in present development and its influence in the establishment of the right kind of laws and customs for the future regulation of water in this district, justifies its efficient prosecution.

In addition to these studies an investigation of the drainage problems of this valley was made under the direction of Mr. Elliott, as will be explained in the report of the drainage work of this Office.

IDAHO.

ALBERT EUGENE WRIGHT, Agent and Expert, in charge.

The irrigation investigations in Idaho during the past year were carried on in cooperation with the State engineer's office. The principal fields of this work were in the valleys of Lost River and Raft

River. On these streams there have been numerous water-right controversies, and much ill feeling has been engendered between ditch owners and settlers because natural conditions make a just division of the stream's flow exceedingly difficult. The uncertain question is the extent of seepage losses, both from the main stream and from the ditches. Mr. Wright made an elaborate set of measurements covering 55 miles of the stream's length. He also measured all of the large and many of the small ditches, and these, in connection with the watermaster's report of acreage, furnished data for the determination of the duty of water, which varied from 2 acre-feet to 80 acre-feet of water for each acre of land irrigated.

The question which confronts the irrigators in this section is how far head gates above should be closed to make up for seepage losses below. There is one place in Lost River where a large part of the water sinks and then reappears. Except during the flood season it seems to make no difference with the flow of the lower part of the stream whether the water in the upper part is diverted or not. The settlers along the upper section contend that their right to divert the stream should be independent of the rights on the lower section, while only definite measurements to show that closing the upper ditches would not benefit them will satisfy the settlers on the lower section that this contention is a just one. The prior rights on the lower section of the stream amount to about three times the average flow of the river, and this year all of the upper ditches were shut off at the request of the holders of these lower prior rights.

Near the lower end of the river a large part of the water sinks. Holders of prior rights along this section contend that it is the use of water above that dries up the channel, although they admit that many times as much water as they claim passes the upper head gates. Because of their contention the water master this year followed the decree rigidly, closed the upper head gates at the demand of the holders of prior rights below, and turned 80 cubic feet of water per second back into the river, although the appropriations of these claimants amounted to only 6 cubic feet per second. Not one cubic foot per second of this reached the head gates of the holders of these prior rights.

The data obtained by Mr. Wright regarding the location and extent of seepage losses will enable the owners of the lower ditches to locate new head gates where they can be sure of a constant supply and, as this season was an average one, the investigations made seem to be conclusive and will not need repetition.

The investigations were begun too late to determine the duty of water for the season, but as this is altogether subordinate to the important question of distribution, it is probable that duty-of-water measurements can be carried on more economically and effectively in other sections.

The studies on Raft River included about 100 miles of the stream and included an interesting interstate problem, the irrigable lands being scattered over 15 townships in Idaho and 4 in Utah. For the irrigation of these lands 16,436 "inches" of water are decreed—a volume greatly in excess of the needs of the land now irrigated and more than the stream can furnish. These excess rights have given rise to many bitter personal and neighborhood quarrels, which have been aggravated by the indefinite description of the box through which these "inches" are to be measured.

The decree establishing water rights on this river limits them to the land named in the findings, but the courts have not upheld this attachment of water to land. The decree also defines the irrigation season as from April 1 to October 1, but specifies that water may be used earlier than April 1 if desired. One irrigator interpreted the word "earlier" to extend to December, and was heavily fined for contempt.

One difficulty in the extension of irrigation in this valley is the uncertainty regarding rights to underground water where it sinks in the channel of small streams or reappears in springs. The attempt to sell seepage water rising on a bench some distance from the river has led to controversy and threatened litigation.

The seepage losses in the channel of Raft River are very great, and the holders of prior rights on the lower end claim that no water should be diverted until the water reaches the head gates of their ditches, basing this claim on the ground that the amount of water needed to supply their priorities, added to the amount lost in seepage, will absorb all the stream carries. Two or three lawsuits over this question have cost the State several hundred dollars defending the water commissioner.

The irrigators on Goose Creek, a stream west of Raft River, have the reputation of being the most skillful and economical users of water in Idaho. Rotation has reached a high degree of perfection, water being divided into rights as small as a quarter of an inch and the time of use regulated to the minute. Water rights are dealt in as real estate and are sold at prices varying from \$12 to \$115 per inch, according to the date of priority.

MONTANA.

J. S. BAKER, Instructor in Civil Engineering, Montana College of Agriculture and Mechanic Arts, in charge.

Investigations in Montana have been carried on in the Yellowstone, Bitter Root, and Gallatin valleys. In the Yellowstone Valley measurements to determine the duty of water have been carried on along one of the large canals, and in connection with this a survey has been made of the entire area irrigated and seepage tests made on a number of the larger canals. In these tests we have endeavored to make meas-

urements at each mile along the canal. This plan has also been followed in our seepage tests in the other two valleys named. In the Gallatin Valley the duty of water experiments have been continued by measurements of the water used on three different farms. We have also made seepage tests on the Kleinschmidt canal, Cameron ditch, and the High-Line ditch of the West Gallatin Irrigation Company. In the Bitter Root Valley three sets of seepage measurements were made on the river, and similar measurements were made on many of the larger canals. The studies of the duty of water in the Bitter Root Valley have included measurements of the quantity used on 15,000 acres of the Bitter Root farm, and at three other farms located at different points in the valley.

In a number of localities in western Montana, notably at Great Falls and in the vicinity of Bozeman, it has been demonstrated that crops can be grown without irrigation, and it is manifest that there are large areas in the State where the addition of a very small supplemental water supply, through the adoption of winter irrigation, the conservation of moisture by proper cultivation, or the construction of small reservoirs or pumping plants, will lead to the settlement and cultivation of large areas where complete irrigation is not practicable. The study of methods for supplementing rainfall by the use of small quantities of water in irrigation is therefore one of the important unsolved problems of agriculture in Montana, and we have selected, 16 miles south west of Great Falls, a 20-acre tract on which to study winter irrigation and different methods of conserving moisture and utilizing small supplies. It is intended to select locations in the vicinity of Helena and Bozeman for conducting similar investigations.

UTAH.

E. R. MORGAN, Agent and Expert; W. W. McLAUGHLIN, Assistant in Irrigation Investigations, in charge.

Investigations in Utah involve cooperative arrangements with both the State experiment station and the State engineer's office. Mr. E. R. Morgan, agent and expert, has been carrying on the work in cooperation with the State engineer's office. This has been the determination of the duty of water in different parts of the Weber River irrigation system. As an aid to this there have been installed in all of the canals, under the direction of the State engineer, adequate head gates and measuring flumes, to permit of an accurate record of the water used. The work this year was largely preliminary to more careful studies next season, Mr. Morgan's time being devoted to putting in rating flumes and weirs, selecting the localities, and measuring the areas where duty of water is to be studied. All the expenses of this work, aside from the salary and field expenses of our agent, have been borne either by the State or the farmers and canal owners.

The Utah Experiment Station, recognizing that the time has come when water must be used with efficiency and economy in order to supply the lands already under ditches, is making a study of the best methods of distributing and using water and has equipped its station with special instruments and apparatus for carrying this on in a systematic way. An agreement for cooperation in this study was entered into in October of the present year. The subjects to be embraced are the determination of the amount of water needed in the irrigation of crops, the time and manner of application to secure the best results, and the ascertainment of the value of water in the irrigation of field, orchard, and garden crops. In addition to this study cooperation in certain drainage studies has also been agreed upon, the purpose of this being to determine the most practical way in which drainage may be carried out by farmers. The reclamation of the overwatered lands of the West rests largely in convincing farmers that drainage will pay. Laboratory or special experiments will not satisfy farmers that it is sufficiently profitable to merit their attention, and it is intended in Utah to inaugurate some drainage experiments under the field conditions that the farmer must use and to cultivate the fields thus drained in the same manner that the farmer has ordinarily followed. In other words, the effort in the drainage investigations in Utah will be to obliterate as far as possible the experimental aspect.

WYOMING.

B. P. FLEMING, Assistant in Agricultural Engineering, University of Wyoming, in charge.

The principal special work in Wyoming was measurements of the duty of water, which were carried on at the agricultural experiment station and on Sand Creek, and in the measurement of the water diverted and the areas irrigated on Horseshoe and Deer creeks. Mr. Fleming also assisted in measurements of water used in Wyoming as a part of the interstate investigation on the Platte River.

COLORADO.

C. E. TAIT, Assistant in Irrigation Investigations, in charge.

The investigations in Colorado were carried on from the central office in Cheyenne under the direction, in the earlier part of the season, of Mr. C. T. Johnston, and later in the year, of Mr. C. E. Tait. Because of the large area of land irrigated, and the high value of water for irrigation, a large number of reservoirs have been constructed, and with this construction the complications growing out of the adjustment of rights to water in the natural streams and in the stored supplies have made the questions of distribution in Colorado

of relatively great importance. These were studied on a number of streams in the Platte River drainage, Mr. Frank Adams having charge of the measurements of the water diverted and the determination of the acreage irrigated in the Cache la Poudre Valley, and Mr. Tait of the measurements to determine the amount of seepage from ditches and fields which returns to the stream. This work had for its primary object the study of the Platte River as an interstate stream. This phase of the work is discussed under another heading.

NEBRASKA.

O. V. P. STOTT, Professor of Civil Engineering, University of Nebraska, in charge.

The work in Nebraska was divided into three parts: The study of the Platte River as an interstate stream; experiments to determine the quantities of water to apply to different crops to obtain the best results, and the study of drainage and reclamation of alkali lands.

The work on the Platte River included measurements of the canals diverting water from both branches of the river from the west line of the State to their confluence, and of those on the main stream. Gauge rods were established in the principal canals near their heads, and records of gauge heights throughout the season were kept for most of the canals. Under some of the canals no irrigation was practiced on account of the heavy rainfall, and no records of gauge heights on such canals were kept.

Measurements of the flow of the branches of the river and the main stream were made in the season of lowest water. These with the measurements of the canals will help to determine the influence of diversions upon the flow of the stream. The measurements on the North Platte extended from the Wyoming line to the junction with the South Platte. Those on the South Platte extended from the Colorado line to Kory Station, about 40 miles below the line, where the flow disappeared. Measurements on the main stream extended from the junction to Kearney.

The work on the Platte included also the gathering of data as to the acreage under the canals, the crops raised, yields, and prices, and the general condition of agriculture in the region.

All preparations were made for measuring the water applied to oats, alfalfa, corn, and potatoes, near Lexington, but the heavy rainfall of the season destroyed the value of the experiments.

The work in drainage and reclamation of alkali lands was largely preliminary. A line of wells was put down for observing the rise and fall of ground water, and surveys for drains on some badly swamped tracts were made. Drains will be made and the observations continued another year.

SEMIARID DISTRICTS.

Between the eastern part of Texas, Oklahoma, Kansas, Nebraska, and the Dakotas, and the distinctively arid country which lies at the western border of these States, there is a broad strip of country which extends from the northern boundary of the United States almost to the Gulf of Mexico, in which there is plenty of rain in many seasons to produce crops, but in other seasons agriculture without irrigation is a failure. In all years the period in which irrigation is necessary is of brief duration. In these sections farmers are confronted by two problems: How to make the limited water supply of that region available, and how to utilize it to the best advantage. There are few large rivers and nearly all the streams are intermittent in character. Water in small quantities can be had, however, over a large part of this area. The gravelly subsoil in many sections is filled with water, or it can be stored in small reservoirs in ravines or natural depressions. In this region there have been recurring periods of wet and dry years which have peopled and depopulated certain sections three or four times. Rainy years attract farmers and dry years drive them away. A special system of agriculture must be worked out for this part of the country, which will include a limited water supply for irrigation to be drawn from wells or streams by pumps or by gravity from small reservoirs when it is stored. With this water supply each settler will be able to irrigate from 10 to 20 acres of ground and be assured in both dry and wet years of an ample supply of vegetables from his garden, fruit for his household from his orchard, and enough alfalfa and forage to support his milch cows and other farm animals.

This investigation has received numerous petitions from individuals and associations of farmers to take up the study of irrigation methods suited to this region, and to outline plans for agricultural development based thereon. We made a beginning by cooperating this year with the station established by the State of Kansas at Hays.

KANSAS.

J. G. HANEY, Superintendent Fort Hays Branch State Experiment Station, in charge.

In cooperation with the State experiment station of Kansas, an investigation to determine the cost of irrigation in the semiarid district and the conditions which affect its profits was inaugurated at Hays, Kans. A centrifugal pump with steam engine was installed and a number of ordinary field crops were irrigated. It was not expected that the results of the first season could be made conclusive; the well had to be dug, the pumps installed, and the land put in condition for irrigation. All these expenses should not be charged against the first year, but it will require two or three years to determine fairly what the financial advantages of irrigation are in this section of the country.

Although the rainfall of the present year was above the average and good crops were grown throughout this region on lands not irrigated, the results of irrigation showed that in such years irrigation is a marked benefit. It increased the yield of corn 46 per cent, Burbank potatoes 95 per cent, and early Ohio potatoes 63 per cent.

For the past two years we have given considerable attention to the possibilities of irrigation by the use of small water supplies in southwestern Texas. In the early spring of 1903 efforts were made to gather the results of practical experience in this region, and these were of such an encouraging character as to warrant the extension of similar investigations in this region to those carried on in Kansas.

Reference has already been made to the investigation in the use of small water supplies in parts of Oregon and Montana. It is believed that these studies should be extended. As we reach a better understanding of the climate and soil of the arid region, we are finding out that the portions of it which are wholly arid are much more restricted than was formerly believed. Scattered here and there are areas where certain crops can be grown every year, where all kinds of crops can be grown some years, and where a small supplemental supply of water will insure success every year. The largest yields of wheat in Washington and some of the finest fruit orchards are in the district which lies on the border line between success and failure in growing crops by rainfall alone. The men who are developing these sections will be greatly aided by the work we have inaugurated in Kansas, Oklahoma, and Texas, and, in addition, the carrying out of these investigations will suggest means of more effectually inaugurating them in these isolated districts.

SOUTH DAKOTA.

A. B. CRANE, Professor of Civil and Agricultural Engineering, South Dakota Agricultural College, in charge.

For the past two years, Professor Crane has been collecting data on the value of irrigation and on irrigation methods employed in South Dakota. In 1902, he reported upon irrigation by gravity in the Black Hills region. In 1903, he made a study of irrigation from wells in the valley of James River. In this valley, artesian wells can be found in many sections, and from 1890 to 1894, many large and costly wells were sunk. The greater part of these were 6 inches in diameter and varied in depth from 500 to 1,300 feet. Few of them proved financially profitable. They cost from \$2,500 to \$4,000. The farmers who made use of the water knew nothing of irrigation and distributed and applied it without any economy or system. The result was that the benefits derived from irrigation did not pay interest on the cost

of the wells, and irrigation development from this source ceased. Within the last year or two a new system has been adopted. This is the sinking of small wells which cost from \$300 to \$650. These are from $1\frac{1}{2}$ to 2 inches in diameter, are within the means of individual farmers, and many of them are now being sunk in this basin.

The work of Professor Crane included studying the methods employed in the utilization of water from these wells and gathering the experience of farmers regarding the benefits derived from their use. The following are some of the conclusions reached:

(1) Irrigation can be practiced to advantage during most of the years, though there is occasionally a year when the moisture is sufficient and properly distributed.

(2) The salts in the waters and those drawn from the land have not thus far had any detrimental effect, nor are there indications that they will in the future. All cases of deterioration of the soil are directly traceable to the use of too much water.

(3) Under irrigation the farmer is practically sure of a crop each year.

(4) In ordinary or extra-dry years the crop is increased two and sometimes three fold.

(5) The crops are always of superior quality, grading number one when unirrigated crops grade number three or are even rejected.

(6) A good 2-inch well with a reservoir will furnish water for a half section of land.

(7) The main drawbacks are the lack of knowledge regarding the handling of water in the field and the too lavish application, especially if soon followed by rain.

(8) Experience seems to show that in many places irrigation is necessary to start the growth of trees which, after once established, will thrive without it. It seems to have been profitable with small fruits, garden products, and alfalfa, but is not regarded with much favor in the growing of small grain.

One of the most interesting examples given by Professor Crane was that of the Joy Brothers, market gardeners, near Huron. They have about 100 acres under irrigation, storing the water coming from a well in a reservoir covering about 5 acres, which they fill to a depth of 4 feet. The water is distributed through 4-inch tile, laid to grade, with cement joints, so that none is lost. At intervals tees or elbows are put in and cemented to short pieces of iron pipe, in which screw plugs are placed. Water is carried from these plugs in open ditches. Distributing the water in pipes has greatly increased the duty by preventing losses from seepage and evaporation. The estimated cost of applying water by this system is about \$1.25 an acre per year. The value of the crops grown in this garden averages about \$200 an acre. Potatoes yield about 200 bushels per acre; cabbage, 5,000 to 7,000

heads per acre; onions, 300 bushels per acre; strawberries, 200 bushels per acre. They raise no small grain under irrigation and can raise corn without irrigation on lands watered the previous year, the subsoil furnishing all the moisture the crop needs.

One drawback to the use of these wells is the salt contained in their waters, and the fear of injury to the soil from its use in irrigation has retarded development.

MISSOURI.

H. J. WATERS, Director Missouri Agricultural College Experiment Station, in charge.

The cooperative investigations carried on with the Missouri State Experiment Station were begun in 1901. Since that time the station has built a small storage reservoir. The water used in these experiments comes from this reservoir and the city waterworks.

During the season of 1903 the experiments included the irrigation of strawberries, asparagus, nursery stock (consisting of apples, peach, and plum trees), onions, and a late irrigation of corn. The season as a whole was not calculated to make a favorable showing for irrigation, as the rainfall of the summer months was considerably more than the average. None of the crops were irrigated until August.

The irrigation of strawberries in 1901 and 1902 having shown its value, this feature of the experiment was dropped. In 1902 one plat of irrigated strawberries produced 276 crates per acre, while the unirrigated one produced only 28. Another irrigated plat produced 290 crates per acre, while the unirrigated produced only 39. Similar results were obtained on all the irrigated and unirrigated areas.

The strawberry beds were irrigated this year to determine the effect of watering young plants. These were set in rows 4 feet apart, the plants 2 feet apart in the rows. The irrigating ditches were made by opening a furrow on one side of each row of plants with a single-shovel plow. The plants were placed on sloping ground and the furrow was run on the upper side of the row, as near to it as possible. Enough water was applied to cover the land to a depth of $5\frac{1}{4}$ inches. There were copious rains, which apparently supplied all the moisture needed by the unirrigated plants. Nevertheless, the effects of this watering can not be determined until next season. The critical period in the life of a strawberry plant is during the month of August, and past experiments in irrigation have shown that, if water is supplied in August, it affects the yield of fruit the next year. This year will determine whether an abundant supply of water furnished artificially is of more value than a moderate amount supplied by rain. Aside from the irrigation, the plants on the irrigated and unirrigated areas were treated in the same way, and both will be mulched alike during the winter.

In the irrigation of asparagus the sections of the field irrigated are 7 years old and have received each autumn for three or four years a

heavy dressing of barnyard manure, well worked into the soil. The rows are $4\frac{1}{2}$ feet apart, the plants growing thickly in the rows in a mass 12 to 16 inches wide. The land slopes gently to the south. The irrigation ditches were made by furrows with a single-shovel plow working as near the plants as possible without injuring them. Through these furrows water was allowed to run until the soil was thoroughly saturated. The total amount of water applied in two days, August 10 and 12, was 2.4 inches, over the area irrigated. Frequent showers kept the soil supplied with more than a normal amount of moisture during the remainder of August and well into September, yet the irrigated rows showed the effects of the extra water they had received. Within two weeks the watered rows began to show signs of renewed vigor; new shoots began to appear and the branches of the mature plants appeared green at the tip. With the waning of September the brownish appearance of the unirrigated rows was quite noticeable, while the irrigated plants continued green; but the most interesting feature of this experiment was the fact that the unirrigated rows were affected with asparagus rust while the irrigated plants were apparently entirely free from the disease. This shows at least that irrigation does not aggravate this disease and gives rise to the possibility that it may afford a means of overcoming its effects. The photographs in Pl. XXIV, fig. 1, show the difference in size and appearance of asparagus plants in the irrigated and unirrigated rows, the stalks photographed being average specimens in point of size from both areas. Pl. XXIV, fig. 2, show near views of sections of the stalks taken from the irrigated and unirrigated rows. The unirrigated were small and showed plainly the effect of disease. The irrigated stalks were large, clean, and healthy. If irrigation shall prove a preventive of asparagus rust it will be of untold value to the gardeners throughout the United States, and if this application of water invigorates the plant sufficiently to cause it to resist a common disease, it is also quite likely that enough surplus food supply will be stored up in the roots to enable them to push out the young edible shoots early in the spring in a more vigorous and abundant fashion.

The nursery stock was irrigated to a depth of 4.67 inches. At the first of November the irrigated trees were not appreciably larger than those not irrigated, but the irrigated trees seemed disposed to continue their growth and probably will outstrip the unirrigated ones, as nursery stock grows until December if it has sufficient moisture.

Four varieties of onions were irrigated, the watering beginning July 27 and continuing until the soil was well saturated, 6 inches over the entire area being applied. The crop was harvested the first of September and a careful record kept of the yield on equal areas of irrigated and unirrigated plats, the yield being weighed at the time of harvesting so as to show the total difference, and then the product



FIG. 1.—IRRIGATION INVESTIGATIONS—ASPARAGUS PLANTS FROM IRRIGATED AND UNIRRIGATED ROWS.



FIG. 2.—IRRIGATION INVESTIGATIONS—EFFECT OF IRRIGATION OF ASPARAGUS DURING AN ORDINARY SEASON, UNIRRIGATED STALKS BADLY AFFECTED BY RUST.

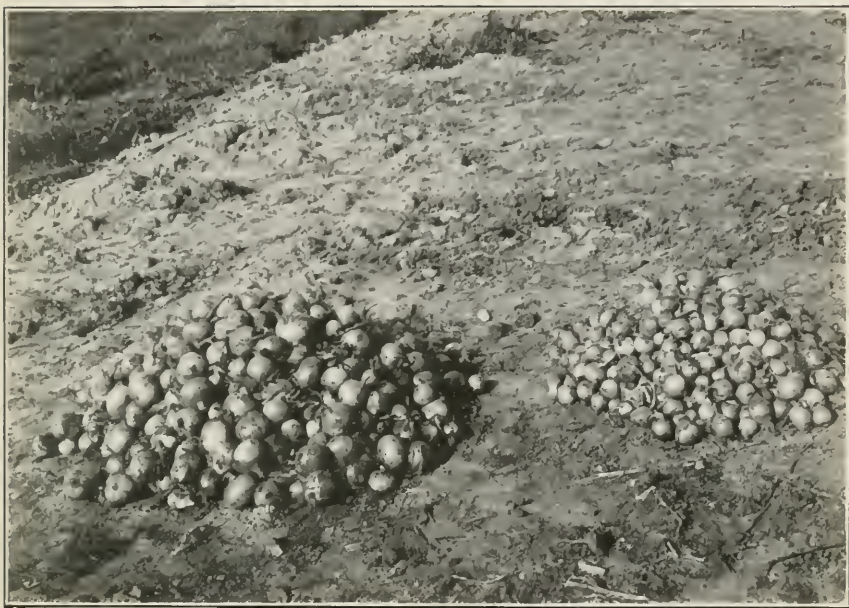


FIG. 1.—IRRIGATION INVESTIGATIONS—YIELD OF ONIONS ON IRRIGATED AND UNIRRIGATED PLATS.



FIG. 2.—IRRIGATION EXPERIMENTS—MOVABLE SPRINKLER.

was divided into three grades based on size. Of the Silver King variety the increase due to irrigation was 77.6 per cent; the White Portugal, 25.5 per cent, and the Yellow Danvers, 67.6 per cent. The percentage of large-size onions on the irrigated plats was still greater, the difference in the appearance of the crops from irrigated and unirrigated plats being shown in the photograph. (Pl. XXV, fig. 1.)

WISCONSIN.

A. R. WHITSON, Professor of Agricultural Physics, Wisconsin Agricultural Experiment Station, in charge.

The irrigation investigations in Wisconsin have embraced studies of the irrigation and drainage requirements of cranberries. The State station has provided for the carrying out of these experiments by securing a lease from the Wisconsin Cranberry Association of about 9 acres of land 10 miles southwest of Grand Rapids. On this the association has planted different varieties of vines, representing all those grown in the United States and Alaska, as well as others received from Norway, Russia, Siberia, and Canada. With these are 2 acres of standard vines on which the results of applying different quantities of water and putting it on and taking it off by different methods will be studied. A small reservoir has been constructed and measurements of seepage and evaporation have been begun.

Success in cranberry growing depends on the proper use of water. It must be applied at the right time and withdrawn quickly at the right time. At the outset the cranberry growers of Wisconsin made no effort to provide for definite control over water. If nature failed to cover the vines at the right time or uncovered them at the wrong time the crop suffered. The severe drought of 1895 almost destroyed the industry in that State. With its revival came better methods. Dams are being built to collect the surplus water and canals constructed to carry the water pumped from the streams; but with this development have come new difficulties. More water is needed, larger ditches are required, and organization of water users to secure more system in drawing off water is needed to prevent the work of one neighbor damaging those below him. Much litigation has been caused by this lack of cooperative arrangements and by the construction of inadequate works. The work of this Office is to aid in the organization of this industry, exactly as it is aiding in the organization of the industry in the arid States, and the first thing needed is expert study in the collection of facts and the aid of expert advice in the formation of plans. The work in that section is being carried on along the following lines:

(1) The collection of data from growers as to the amount of water used and their methods of applying it.

(2) The determination of losses from seepage and evaporation from ground covered by vines as well as from reservoirs.

(3) The determination of the effect of standing water at different temperatures on berries and vines in various stages of development and under various conditions of weather.

(4) The determination of the coefficient of resistance of peat ditches used for carrying water to and from the vines.

(5) The determination of the most effective methods of using water to prevent injury from frost.

(6) The effect upon the cranberry marshes of the drainage of adjacent areas for farm purposes.

The results of the present year, while not conclusive, show how greatly the success of this industry will be promoted by an efficient system of canals for getting the water on to the ground and getting it off. On June 11 of this year there was danger of frost. Those who had proper ditches saved their crops. Those who were not so provided lost them. A conservative estimate of the loss in the Cranmoor and Mather regions places this loss at \$25,000. The damage due to improper drains in this region, which prevented the removal of the water in time, was greater than that from frost, so that from these two items in the two districts there was a net loss this year of over \$75,000, a sum which would probably be nearly sufficient to construct a system of canals to meet the demands of both districts.

NEW JERSEY.

E. B. VOORHEES, Director New Jersey Experiment Station, in charge.

For several years this Office has been cooperating with the State experiment station of New Jersey in a study of the benefits of irrigation to market gardeners and experiments with methods of distributing and applying water to the sandy lands along the Atlantic seaboard. The report of Professor Voorhees in 1902 illustrated and described some experiments with ditch lining which had proven effective. Further experiments in this direction were continued this year.

In addition to the investigations at the station and in the sandy lands of southern New Jersey, Professor Voorhees visited a number of the market gardeners who are irrigating in the vicinity of New York and Boston, in order to learn something of their methods and whether or not it has paid. All of the reports were favorable, some of the results surprisingly so. The general conclusion seems to be that whenever market gardeners can obtain a water supply by gravity, or by pumping it to a height of 30 feet, it will pay to irrigate, and that ability to secure an emergency supply at much greater expense often saves a year's crop. The 14 market gardeners interviewed this year have been irrigating from one to twenty-five years; not one proposes to abandon the practice.

The report of Mr. David Astle, of Vineland, N. J., will serve as an illustration of the others. He irrigates potatoes, beets, onions, tomatoes, celery, Lima beans, cabbage, etc. His water supply comes from driven wells, is pumped into a tank, and distributed from there through pipes attached to movable sprinklers, the form of sprinkler being devised by Mr. Astle. It is a long pipe, supplied at intervals with spraying nozzles and supported by means of a wheel framework. Water is introduced into this by means of a rubber hose. The ground to be watered is supplied from a series of iron pipes, and when one section has been irrigated the rubber hose is uncoupled and attached to the next tap on the supply pipe. (See Pl. XXV, fig. 2.) The results of Mr. Astle's experience this year is told in part in a letter, from which the following extract is taken:

I began irrigating in 1899. The first crop watered was an acre of cabbage and the experiment was a great success. In the spring of 1900 I irrigated cabbage, beets, potatoes, and onions with excellent results. Irrigation worked so well that I watered all the crops which could be reached with our pipes. Among the crops were two plats of potatoes, one of which was irrigated and one could not be. The yield from the same area of the irrigated plat was four times that of the unirrigated. In 1902 we irrigated half a plat of ground and left the other half unirrigated. The unirrigated half was two weeks later in maturing and the produce greatly inferior in quality and quantity.

During the spring of 1900 we irrigated garden crops adjacent to a field of hay and some of the water fell on the meadow. We harvested twice as much hay from the irrigated portion, although the rainfall for the season was abundant.

During the present year we have irrigated a plat of 246 square rods, 227 of which was planted in potatoes. We began irrigating these March 10 and began digging June 10. They were all sold by the 20th, and we received a little more than \$272 for the crop at wholesale rates. During the growth of this crop we had a period of seven weeks in which not a drop of rain fell and without irrigation the crop would have been a complete failure. After the potatoes were harvested 207 rods of the ground was planted in celery. Some of this was injured by a heavy rain and wind-storm while being bleached, but up to the present we have sold at wholesale \$278 worth, and more than half remains unsold.

LOUISIANA AND TEXAS.

MORTON A. ALDRICH and W. B. GREGORY, professors in Tulane University, in charge.

Five stations for the measurement of the amount of water used in rice irrigation were established in Louisiana and Texas and complete records obtained from three of them. The others were injured by the breaking of levees, which turned the water in or out of the fields where measurements were being kept, and thus destroyed the accuracy of the records.

During the summer of 1902 this Office collected a large number of samples of salt water for the Bureau of Chemistry, and this year our agent has visited the fields on which this water was applied to see whether its effects were noticeable in the subsequent crop. No diffi-

culty was encountered from the salt water in 1903, the fresh-water supply having been ample. A dam is being constructed in the Mementau River in order to keep out the salt water in seasons of shortage. The effect of this will be watched with much interest.

Data has been collected to show the cost of pumping water and to assist in determining the efficiency of different types of pumps. The collection of samples of salt water for the Bureau of Chemistry was interrupted by a change in our agents, but arrangements are being made for the renewal of this cooperation in 1904.

The time of Professor Aldrich was given to the collection of data showing the cost of supplying water, the character of the rental agreements, and other social and legal questions connected with the use of these streams in irrigation.

INVESTIGATIONS ALONG THE ATLANTIC SEABOARD.

In February last year, in company with Mr. Samuel G. Stoney, I made an inspection of the rice plantations along the Cooper River, near Charleston, S. C., for the purpose of ascertaining what could be done for the betterment of conditions along this river. Ever since the war the rice industry along this stream has languished, the total area under cultivation being only about half what it was a half century ago, and many of the plantations and buildings have been abandoned for many years.

The inspection was made from a gasoline launch, and we stopped at a number of places where dikes were being built and repaired and saw a number of plantations on which the cost of repairing dikes has led to their disuse. This was the second visit made to this district and it confirmed the conclusion formed at the first one, that the thing most needed to restore the rice industry in this part of the country to its original prosperity is the organization of all the planters along each river into some sort of a cooperative body, having for its object the maintenance and repairing of the levees according to systematic plans. Such an organization of rice growers would permit of the operation of modern up-to-date machinery for the driving of piles and the building of dikes, and this would lessen the expense of repairs by at least one-half and would greatly improve the character of the work when completed. Such an organization would insure protection of the levees along the stream. As it is now one negligent planter often endangers the safety of the plantations above and below him.

The building of better levees is one of the measures needed to insure the protection of these plantations in time of flood. Other improvements are needed to insure an ample water supply in time of drouth. Subsequent to my visit some drainage surveys were made by Mr. Elliott of this Office to ascertain the feasibility of securing a supplementary water supply during the low-water season. It is

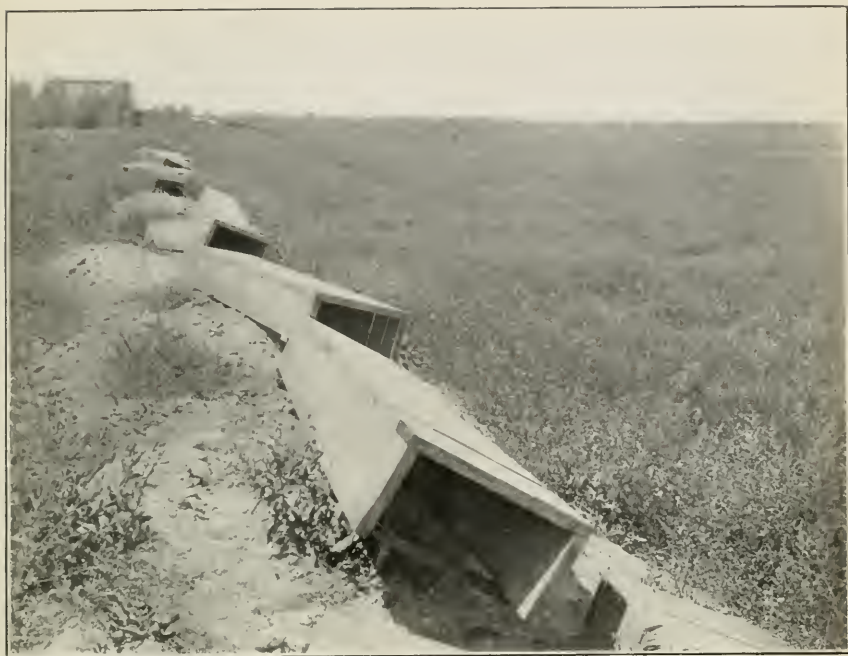


FIG. 1.—IRRIGATION INVESTIGATIONS—WOODEN UNDERDRAIN USED IN THE REMOVAL OF SEEPAGE WATER AND ALKALI.



FIG. 2. IRRIGATION INVESTIGATIONS—AN OPEN DRAIN FOR THE REMOVAL OF WASTE AND SEEPAGE WATER.



IRRIGATION INVESTIGATIONS—DRAIN DITCH FOR REMOVAL OF SEEPAGE WATER AND ALKALI FROM A HOP YARD.

believed that these studies of dikes and drains should be continued until enough information has been gained to enable this Office to make definite recommendations for the improvement of the rice industry of this region.

At the request of Mr. J. H. Stewart, director of the State experiment station of West Virginia, a visit was made to Parkersburg in order to determine whether or not a feasible location could be obtained for pumping water from the Ohio River to irrigate a small experimental tract in the vicinity of this city. The wide difference between the high and low water levels of this stream is not a favorable condition for pumping, and it was concluded to examine some of the tributary streams to see if a reservoir which would furnish water by gravity could not be built. The search for such location has not yet been completed.

DRAINAGE INVESTIGATIONS.

C. G. ELLIOTT, Expert in Drainage, in charge.

From drainage surveys made in the Fresno district, California, in 1902, plans and estimates were made and published in circular No. 50 of the Office of Experiment Stations. The tract for which drainage was proposed contains about 25 square miles of fruit land which requires drainage to reclaim it from injury which has resulted from excessive quantities of soil water and alkali. Through the efforts of those intimately concerned in the drainage of land in that State requiring combined effort, the passage of a drainage law was secured during the session of the legislature in 1902-3, and a district is now being organized under its provisions. During the summer of 1903 measurements of the fluctuation of ground water were made for the purpose of ascertaining more accurately than had previously been done the quantity of water that should be removed by drainage. These measurements lead to the conclusion that during the month of March 0.15 acre-inch should be drained from each acre in twenty-four hours, in April 0.08 acre-inch, and in May 0.02 acre-inch, in order to prevent the soil water line from rising. The tile-drain system proposed for that district is designed to remove 0.09 acre-inch each twenty-four hours. This, from investigations thus far made, it is believed will meet the requirements.

At the request of farmers at Sunnyside, Wash., who desired some assistance, examinations and surveys of land showing seepage and alkali were made in the early part of the season of 1903. Drainage for 1,500 acres was planned and surveys, with estimates of cost, were made, together with suggestions for necessary supplemental farm drainage. A district for the execution of this work has been organized in accordance with the provisions of the State law.

The Ahtanum Valley and lands about North Yakima were carefully

examined during the season. A large underflow of water passes from the higher lands bordering the valley on the north and accumulates on the lower lands during the season. As a result many acres now show serious injury. Drains were laid out for intercepting the soil water from the lands of some farmers who see the necessity of drainage. Suggestions upon the drainage required for several farms have been offered, and investigations have been made in the lower Ahtanum Valley with the view to determining what method should be adopted to reclaim it as a whole from the injury which it has already received from overirrigation and from seepage from higher lands.

Examinations have been made of wet lands in the Grey Bull Valley, near Burlington, Wyo., where the rapid seepage of water through the open gravel beneath the soil has ruined portions of the richest valley land. A simple drainage plan was proposed, which met with favor, and will probably be followed by a few of the most progressive farmers.

For the reason that the last two seasons have been excessively wet in the Central West drainage has received marked attention during the past year. The absolute necessity of this improvement has been forced upon the attention of farmers, especially in the States of Iowa and Missouri. During the five or six years previous to the last two there was only an average rainfall, while one of them (1901) was unusually dry. These years were favorable for the opening up and cultivating of lowlands which, with little or no artificial drainage, produced large crops. The success which attended the cropping of these rich lands under conditions of normal rainfall led to the cultivation of a large acreage of lands which had hitherto been neglected. A considerable part of the Missouri Valley lands between Sioux City and Council Bluffs, Iowa, are of this kind. In Monona and Harrison counties not less than 75,000 acres have been rendered unproductive during the past year, much of it being land equipped with good improvements. The Little Sioux River, with its tributaries, overflows its banks when at flood height. From the fact that the banks of both the Little Sioux and Missouri rivers are higher than the land between them, the overflow of this stream and the water of rainfall must flow parallel to both until it may be discharged into the Missouri River at some lower point. The difficulties connected with the drainage of this valley are twofold—(1) protection of the lowlands from the overflow of the streams, and (2) provision for disposal of the surplus rainfall.

The plan proposed for this improvement consists in straightening the little Sioux River by making cuts across circuitous bends, thereby adding one-half to its carrying capacity. For the more complete drainage of the land itself it is proposed to build a large relief ditch, 22 miles long, which will discharge into the Missouri River. These improvements are estimated to cost \$238,000, for which it is proposed

to tax 58,000 acres of land. A public meeting was held at which a representative of this Department was invited to explain the plans and discuss their adaptation to the needs of the portion of the valley under discussion. Several propositions for draining lands in Woodbury County, lying directly north of Monona County, were briefly examined and the people of that county, at their request, were addressed at a meeting held at Salix, where the feasibility of the plans proposed, as well as the general principles involved in the drainage of level lands, was discussed.

In Buena Vista County the improvement of Coon River is proposed. The channel at the headwaters of this stream is a mere slough, which has been used as an outlet for surface and tile drainage, but, owing to the unusual rainfall, a large acreage of land which has been tile-drained at considerable expense has been flooded. The improvement of this river will involve provision for the drainage of approximately 115,000 acres. The drainage expert of this Office was called upon to confer with the county auditor, attorney, and engineer regarding the proper steps to be taken for starting this project in accordance with the State drainage laws. Surveys for this work are now being made. It should be observed in this connection that the provisions of the State drainage law are meager, many regulations for carrying out efficient drainage work requiring the cooperation of landowners being wanting. Much confusion has arisen in the attempt to organize districts to execute work in accordance with the law. The county auditors of the State have a committee which is instructed to formulate such amendments as occur to them as necessary. A drainage convention is called to meet at Ames, January 15-16, 1904, for a conference upon changes needed in the law and for a complete discussion of the methods required in combined drainage. A representative of this Office has been asked to meet with this convention.

A large amount of drainage work is being arranged for in Hancock County, where the present drainage districts were examined, the aggregate estimated cost of the proposed work being \$250,000. Written reports were prepared upon each of the general projects described, containing recommendations to both supervisors and engineers. A summary of the approximate estimated cost of the work which has been examined and upon which advice has been given is as follows:

Swamped lands under ditches at Fresno, Cal	\$236,000
Sunnyside, Wash	3,500
North Yakima, Wash	12,600
Monona County, Iowa	238,000
Hancock County, Iowa	250,000
Buena Vista County, Iowa	125,000
Santee and Cooper rivers, S. C.	491,000

1,356,100

Advice has been asked relating to levee work for the further protection of valuable lands on the Illinois River bottom in Greene County, Ill. Large interests are here involved and the work is still under consideration. Nearly all of the levees along this river, being of a somewhat temporary character, were broken last year and the land inundated, entailing a large loss upon the owners as the crops were entirely destroyed. A move for heavier and more complete work is now under consideration in many localities.

In portions of the South cultivated hill lands are greatly injured by erosion, many otherwise valuable fields having been abandoned on account of surface washing. An experiment was tried in northern Georgia last spring in which tile drains were used to prevent hillside washing. After the drains were laid, all existing gullies were filled and the land leveled off. The report from that field states that one good crop has been taken off and that there is every indication that the experiment will prove a success.

In South Carolina, at the solicitation of rice growers along the Cooper River, a survey was made to determine the feasibility of diverting water from the Santee River to the west fork of the Cooper for the purpose of increasing the amount of water in the latter river, which is a tide-water stream, for the benefit of the rice fields in that valley. This project was found feasible, but, owing to its magnitude and the cost of the proposed work, it has not received serious attention from those most interested.

LAWS AND SOCIAL INSTITUTIONS.

Under the clause of the appropriation law providing for the study of laws and institutions relating to the use of water, work has been done both in this country and abroad.

The work of the year in this country included the publication of a report on irrigation in Utah, the field work for which was done in previous years; the publication of a bulletin on the acquirement of water rights in Colorado which has been in preparation for a year or more; and the field work for a study of the Platte River as an interstate stream.

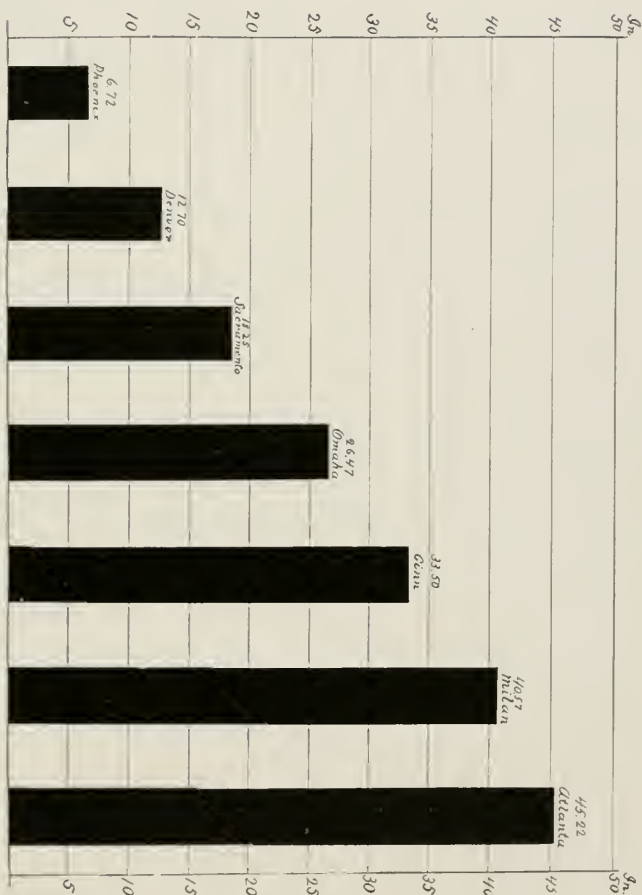
The branches of the Platte River rise in Colorado; one flows through Wyoming into Nebraska and the other flows directly from Colorado into Nebraska. Rights to these streams have been acquired under State laws, each State in determining the rights to water ignoring rights in the other States, although the United States courts and the supreme court of Wyoming have held that rights in one State are subject to prior rights to the same stream regardless of State lines. Further, Colorado and Wyoming have abrogated the doctrine of riparian rights under which water can not be taken from streams to the detriment of riparian lands, while the Nebraska courts have upheld this doctrine. It will be seen that the only intelligent basis for determin-



FIG. 1.—IRRIGATION INVESTIGATIONS—VIEW NEAR BINGEN, GERMANY, SHOWING PROTECTION OF HILLSIDE FROM EROSION.



FIG. 2.—IRRIGATION INVESTIGATIONS—VIEW OF IRRIGATED FARMS IN ITALY.



IRRIGATION INVESTIGATIONS—DIAGRAM SHOWING THE RELATIVE RAINFALL OF MILAN,
ITALY, AND SEVERAL CITIES IN THE UNITED STATES.

ing whether each State can justly ignore rights in the other States, or whether the recognition of riparian rights in Nebraska conflicts with rights of diversion in Colorado and Wyoming, is the physical data as to the effects of diversion on one section of the stream upon the flow of the stream in lower sections. The work so far done has been very largely confined to the collection of these physical data. It included measurements of the streams at points throughout their courses and measurements of the water diverted by canals. The stream measurements were made under the direction of Mr. C. E. Tait, of this Office, and the measurements of diversion under the direction of Mr. Frank Adams, of this Office. In addition to this, the economic phases of the subject were studied by Prof. Richard T. Ely, of the University of Wisconsin, and the laws and decisions were studied by Mr. W. B. Dunton, of this Office. Questions similar to those being studied on the Platte are now involved in the case of Kansas against Colorado before the Supreme Court of the United States, and it is believed that the data gathered on the Platte will help in an equitable decision of this case, since the conditions on the two streams are very similar, and will prevent other similar cases from arising. The report of this work will be published during the coming year.

The work for the past year in foreign countries included the publication of a report on Irrigation in Egypt, by Mr. C. T. Johnston, the field work for which was done in the preceding year, and an investigation of the laws, forms of organization, and practices affecting irrigation in Italy.

The report on Egypt is based on a study of the irrigation works and practices in that country made in the winter of 1901-2. The United States Government was about to enter upon the construction of irrigation works; the Egyptian Government was about to complete two large dams, making the system adopted by that government of especial interest to this country. Mr. Johnston's conclusion was, however, that political and social conditions differed so widely in the two countries that no comparison could justly be made. Drainage as a means of removing alkali from lands has been very extensively carried on in Egypt, and the report gives valuable suggestions as to this practice. It also described fully the water-raising devices used in that country, where a large part of the water used in irrigation is lifted. Copies of the law governing the use of water were obtained and translations made.

The work in Italy was taken up during the summer of 1903. July, August, and part of September were spent in Europe studying irrigation. Germany, Switzerland, Italy, and France were visited. The methods of protecting hillside farms along the Rhine from erosion were briefly inspected (see Plate XXVIII, fig. 1), but the greater part of the time was given to studying irrigation methods and laws in the valley of the Po, the similarity of its conditions to those of the central part of the United States, giving the results unusual practical value.

The rainfall of this part of Italy, as compared to that of the United States, is shown in the diagram (Pl. XXIX). It is not only far above that of the arid region, but above that of Omaha, Kansas City, or Cincinnati. The two important crops which can not be grown without irrigation are rice and marcite. Of these the most profitable is marcite, which is grown in meadows kept green throughout the year by running water over the land almost constantly. Marcite cultivation can be practiced only where warm water can be had in winter, either from springs or sewage from cities. This warm water keeps the grass growing throughout the coldest weather. It is cut when about 18 inches high, and as a rule is fed green. The annual acreage value of the crop is surprisingly large, the products from some fields last year having sold for \$300 an acre.

Land and water rights in the best marcite districts equal in value the best fruit lands in California, some of the farms near Milan being valued at \$3,000 an acre, and the water right at \$1,200 an acre. These are maximum prices and are far higher than those which prevail where only ordinary crops can be grown. The minimum prices for land and water in the districts recently brought under irrigation range from \$160 to \$180 an acre. Unirrigated land in the same neighborhood sells for about \$100 an acre.

The landscape in Italy is rendered beautiful by growing trees and brush along the ditches and roadsides (Pl. XXVIII, fig. 2). The purpose of this is to supply fuel for cooking and heating purposes on the farm. An added attraction is given to the landscape in some of the irrigated districts by the manner in which grapevines are trailed from tree to tree along the margins of the fields so as to form a series of decorative archways. The appearance of the crops on the unirrigated lands resemble those of Kentucky, Indiana, or Missouri. The grass along the roadside was green, and the sharply defined lines between the irrigated and unirrigated farm, so strikingly manifest in the arid region of this country, does not appear there. The same crops grow above the ditches as below them, but there is a luxuriance and increased growth and yield on the irrigated farms which can not be obtained where moisture comes only from rain.

The oldest canal inspected in Lombardy was constructed in 1150. This was built by the monks and was small and crooked, as were nearly all the canals built during the next five hundred years. The land could be farmed without irrigation and the building of canals meant increased expenditure, more people to cultivate the land, more houses for them to live in, and more barns in which to store the products. The large outlay in other directions, besides the cost of ditches, retarded the change, but in recent years progress has been rapid, because of the need of finding employment and support for the dense population, there being about 380 people to the square mile in the

province of Milan. There are several important ancient canals which are used for navigation, but many of the large irrigation canals have been built within the past fifty years. Among those visited, the last to be completed cost about \$1,200,000 and has been finished about five years.

One of the instructive features of Italy's irrigation system is the way in which farmers have united in cooperative societies to build and operate canals or to distribute water from laterals. The largest of these societies is the Irrigation Association of Vercelli. It has 14,000 members and controls the irrigation of 141,000 acres. It supervises the operation of over 9,000 miles of canals and ditches, with 40 water masters, and has about 266 miles of telephone lines. It buys water at wholesale and pays on an average \$170,000 a year for the quantity purchased. The main society is divided into 40 subordinate societies, each of which elects a member to a general assembly which directs the policy of the association. This society transacts a business of about \$600,000 a year.

One of the effects of these cooperative societies is the absence of friction and controversy between neighbors and neighborhoods, so often manifest in the United States. In the society above referred to there has never been an appeal from the decision of the manager, nor a single instance of a member's failing to pay his water rentals. In traveling through a region in which 27,000 cubic feet of water per second was being distributed every day, there was not a single complaint of injustice or extortion, not a fear expressed by any farmer that he would not receive his share of water when his turn came.

Much of the land is farmed by tenants and, as the area each cultivates is small, the general practice is to rotate the use of water along the laterals. These rotations are worked out with a system not approached anywhere in the United States outside of Utah and a few ditches in southern California. In one instance the turn of a farmer was only one hour each week. It began at 7 o'clock Monday morning and ended at 8 o'clock. Each seventh day there was a watering which could be absolutely relied upon. The farmer paid about \$6 a year for the watering of each acre. In looking over the accounts of one association the largest annual payment by any farmer for water was found to be about \$1.200 and the smallest 4 cents.

The government exercises absolute control over the public streams and regulates the amounts each canal may divert. Parties wishing to build new canals must obtain the Government's consent. No perpetual rights to water are now granted. Appropriations are treated as franchises and their life is limited to thirty years. On the other hand, the Government is liberal in its treatment of meritorious projects, frequently extending aid by paying the interest on bonds issued to secure funds to build canals, the usual plan being to pay 3 per cent for the

first ten years, 2 per cent for the second ten years, and 1 per cent for the third ten years, so that the interest payments by the Government end with the expiration of the water right. When the right expires it may be renewed just as franchises are renewed in this country.

In many sections of Italy canal companies have experienced the same losses and farmers suffered the same injury from seepage as are met with in this country. In some instances canals have had to be cemented for their entire length. Drainage has also had to follow canal building, as the seepage water fills the farmers' fields and the cellars of houses in towns. In recent years the granting of rights to build canals is frequently conditioned on the canal company constructing, along with its irrigation works, a complete system of drains to carry off the surplus water. In some districts drainage works have been built under an agreement whereby the canal company pays 40 per cent of the cost of drains and receives the water they collect, the farmers and the municipality paying the remainder.

The results of irrigation in Italy encourage the belief that it is destined to be a large factor in the agriculture of humid parts of the United States, especially in those sections where streams have fall enough for water to be diverted and distributed by gravity and in the Southern States where the long, hot seasons will make irrigation of great value to farmers in the growing of hay and forage crops and in the production of fruits and garden products.

Irrigation is not for the arid West alone. The conditions which have led to its adoption in the humid parts of Germany, Switzerland, France, and Italy are beginning to appear in the Eastern States and, with increasing population and high land values, canal and reservoir building will soon become as important a feature of farm improvement along both slopes of the Alleghenies as it is now along the southern and western slopes of the Alps.

PRACTICAL EXPERIENCE.

During the past year the collection of information as to methods employed in the practical operations of irrigation farming has been begun. All agents of the irrigation investigations were requested to collect and send in descriptions of the best practices in performing certain operations observed by them in the sections where they were working, accompanying their reports with drawings and other illustrations made in the field. These reports are all brought together in the Office, and bulletins on the different operations are being prepared giving the results of the experience of the whole country on these particular lines. New subjects will be taken up each year until the whole field of irrigation practice is covered. It is a slow and expensive process for each farmer to work out for himself the best ways of

doing his work, and it is impossible for any number of them to go over the country investigating the methods of others. The Department can do them no greater service than to collect this information and place it in available form for all who want it.

The subjects taken up in this way during 1903 were raising water with current wheels and preparing land for irrigation. The agents sent in descriptions, drawings, and photographs of wheels seen by them in all parts of the country, with statements of the quantities of water raised, the area watered, and the cost of the wheels. A bulletin compiled from these reports will soon be published and will be available for anyone applying for it. There are many places where small quantities of water can be raised in this way with almost no cash outlay, and this bulletin will serve to suggest the making of wheels to parties living where they can be used and will tell them how to make them.

In the same way the reports on methods of preparing land for irrigation will be combined and published. The operations discussed are: Removing sagebrush, smoothing and leveling land, and laying out and constructing laterals, checks, embankments, etc. These are practical operations which must be performed by everyone bringing land under irrigation for the first time. In addition, the persons reclaiming such land are usually inexperienced in irrigation. The publication and distribution of a bulletin telling what must be done and how to do it will save such persons from making costly mistakes and enable them to put their land in condition with the least possible trouble and expense.

The scope of this work for 1904 has been somewhat enlarged. It has been proposed to carry on the work in cooperation with the agricultural experiment stations of the States, as well as through our agents. Looking to this end a conference was held in Washington, during the meeting of the Association of Agricultural Colleges, between the representatives of this Office and those of the stations interested. At that meeting both the general plan and many of the details were discussed and the plan was unanimously indorsed. In order to determine what questions should be taken up it was decided that the chief of irrigation investigations should prepare a list of subjects which should be sent to each station interested, and that the director of each station should indicate on the list the order of the importance of those subjects and any others which he wished to add and return the list to the Office. The two subjects shown by all the lists returned to be deemed most important will be chosen to be taken up the coming year and will be studied by all the stations, this Department furnishing a part or all of the funds and digesting and publishing the results. In this way the Department will secure the services of the expert staffs of the

experiment stations and the use of their equipment at a very small expense and will secure uniformity in the lines of work taken up. Adding to this the observations of our own agents will make possible the publication of a series of bulletins on the practical operations of irrigation farming which will be of very great value to our farmers and to our agricultural schools which are now hampered by the lack of text-books on such subjects. As the country becomes more thickly settled agricultural progress will be more and more limited to improvements in methods, and this Office is doing what it can to promote this means of progress.

The following are the subjects suggested to be taken up by the stations in the arid region:

- (1) Measuring water.
- (2) Losses from seepage.
- (3) Removing grass and aquatic plants from canals and ditches.
- (4) Employing cement and concrete in the place of wood in farm structures, such as watering troughs, feed boxes, water pipes, irrigation flumes, and the lining of canals.
- (5) Measurements of the rise of ground water in the soil.
- (6) Construction of small reservoirs.
- (7) Construction and operation of open drains now in use in irrigation.
- (8) Construction and operation of underdrains now in use in irrigation districts.
- (9) Methods of laying out and constructing checks or compartments.
- (10) Inquiries regarding certain classes of farm machinery in general use, with a view to determining what problems farmers meet in their use and in what directions studies may be required for their improvement. The relative efficiency of windmills and gas engines in pumping and in supplying power for other kinds of farm work, the problems connected with the use of traction engines in general farm work, and the relative merits of disk and moldboard plows, are examples of special inquiries in this field.

Another list was suggested for the humid States, as follows:

- (1) Employing cement and concrete in the place of wood in farm structures, such as watering troughs, feed boxes, and water pipes.
- (2) The use of tile drains to prevent the erosion of hillsides.
- (3) Methods of terracing hillsides.
- (4) Construction of small reservoirs.
- (5) Cranberry irrigation.
- (6) Irrigating market gardens.
- (7) Irrigating rice.
- (8) The relative efficiency and cost of iron, canvas, wood, vitrified pipe, and cement as a material for conduits for carrying water for irrigation and other farm purposes.

(9) Methods of constructing and maintaining dikes for the irrigation of rice and in preventing the flooding of swamp and overflowed lands.

(10) Inquiries regarding certain classes of farm machinery in general use, with a view to determining what problems farmers must meet in their use and in what directions studies may be required for their improvement. The relative efficiency of windmills and gas engines in pumping and in supplying power for other kinds of farm work, the problems connected with the use of traction engines in general farm work, and the relative merits of disk and moldboard plows, are examples of special inquiries in this field.

PUBLICATIONS.

R. P. TEELE, Editorial Assistant, in charge.

The irrigation publications for the fiscal year ended June 30, 1903, included 5 bulletins, a report to the Director of the Office, 2 Yearbook articles, and 1 circular, making a total of 901 printed pages. In addition, separates of bulletins previously published were issued, aggregating 681 pages, and reprints of other bulletins, containing 119 pages. This makes a total of 1,701 pages of printed matter issued during the year, 901 of which was new matter. The new publications were as follows:

Bulletin No. 124. Report of Irrigation Investigations in Utah. By R. P. Teele, A. P. Stover, A. F. Doremus, J. D. Stannard, Frank Adams, and G. L. Swendsen. Pp. 336, pls. 19, figs. 2. Price, \$1.10.

This is an exhaustive study of the irrigation laws of Utah from the standpoint of their relation to agricultural development and of the customs and institutions which have grown up under these laws. The distinctive features of Utah irrigation are the cooperative canal companies and their rules for distributing water to their members. The reports contained in this bulletin show very clearly how these companies are organized, how they distribute water, and the cost of water to their members.

Bulletin No. 130. Egyptian Irrigation. By Clarence T. Johnston. Pp. 100, pls. 24, figs. 9. Price, 30 cents.

Mr. Johnston spent the winter of 1901-2 in Egypt studying the irrigation laws and practices of that country and inspecting the irrigation works. This bulletin contains the results of his studies. It gives a description of the country, the agricultural methods in use, and the canals and structures connected therewith, including the great Assuan Dam which was nearing completion at the time of Mr. Johnston's visit. The main features of the system of distributing water are also discussed and the texts of the more important parts of the irrigation laws are given.

Bulletin No. 131. Plans of structures in use on irrigation canals in the United States, from drawings exhibited by the Office of Experiment Stations at Paris in 1900 and at Buffalo in 1901, prepared under the direction of Elwood Mead. Pp. 51, pls. 22. Price, 60 cents.

This is an album of plans chosen from those exhibited at Paris and Buffalo. The plans are accompanied by explanations, bills of materials, and statements of cost of construction, maintenance, and repairs, and of their efficiency and durability.

Bulletin No. 133. Report of Irrigation Investigations for 1902, under the direction of Elwood Mead, chief. Pp. 226, pls. 12, figs. 16. Price, 25 cents.

This is the fourth of the series of annual reports of the work of the irrigation investigations. It does not, however, contain reports of all the work done nor any summing up of the work, but is a collection of reports on the agricultural conditions in various localities studied by our agents during the year. It contains the following reports: Irrigation in the Mountain Water District, Salt Lake County, Utah, by E. R. Morgan; The Use of Water from the Wood Rivers, Idaho, by J. D. Stannard; Irrigation Investigations on Sand Creek, Albany County, Wyo., by Burton P. Fleming; Irrigation in Washington, by O. L. Waller; Irrigation Investigations in Montana, 1902, by Samuel Fortier; Irrigation Systems on Stoney Creek, Cal., by W. T. Clarke and C. W. Landis; Irrigation in the Black Hills, S. Dak., by A. B. Crane; Rice Irrigation in Louisiana and Texas, by Frank Bond; Third Progress Report on Silt Measurements, by J. C. Nagle; Irrigation Experiments at the Missouri Experiment Station, by H. J. Waters; Irrigation in Wisconsin in 1902, by A. R. Whitson; Irrigation Investigations in New Jersey, 1902, by E. B. Voorhees; The Use of Pumps for Irrigation in Hawaii, by Jared G. Smith.

Bulletin No. 134. Storage of Water on Cache la Poudre and Big Thompson Rivers, by C. E. Tait. Pp. 100, pls. 5, figs. 10. Price, 10 cents.

This bulletin contains descriptions of the reservoirs built for storing the water of the two streams named, giving capacities, costs, details of construction, and data as to crops raised with stored water. These reservoirs have been built by the associated efforts of the farmers using the water and are, therefore, especially instructive to others similarly situated.

Review of Irrigation Investigations for 1902, by Elwood Mead, chief. Pp. 25, pls. 5.

This is a reprint from the Annual Report of the Director of this Office. It gives a summing up of the work done during the previous fiscal year.

Some Engineering Features of Drainage, by C. G. Elliott. Pp. 14, pl. 1, figs. 2.

Reprint from Yearbook for 1902. It contains a general discussion of some phases of drainage and describes what has been done in a few places.

Circular No. 50. Preliminary Plans and Estimates for Drainage of Fresno District, Cal., by C. G. Elliott. Pp. 12, pls. 2.

This circular discusses the practicability of drainage as a remedy for alkali and gives the surveys for laying out the drains considered necessary for a tract of 25 square miles around the city of Fresno, and estimates of the cost of their construction.

Separates were printed as follows:

Bulletin No. 119. Report of Irrigation Investigations for 1901. No. 1 contains: Summary of Results, by R. P. Teele; Irrigation in New Mexico, by W. M. Reed; Irrigation Investigations in Salt River Valley, by W. H. Code; Irrigation at the Arizona Experiment Station Farm, by A. J. McClatchie. No. 2 contains: Subterranean Water Supply of the San Bernardino Valley, Cal., by E. W. Hilgard; Duty of Water under Gage Canal, Cal., by W. Irving; Duty of Water in Tule River Basin, Cal., by A. E. Chandler; Use of Water in Irrigation in Washington, by O. L. Waller. No. 3 contains: The Distribution of Water from Canals in Idaho, by D. W. Ross; Investigations in Montana, 1901, by Samuel Fortier; Irrigation in Bear River Valley, Utah, by Arthur P. Stover; Irrigation in Grand and Arkansas Valleys, Colo., by Arthur P. Stover. No. 4 contains: Irrigation Under Great Eastern Canal, Nebr., by O. V. P. Stout; Irrigation at the Missouri State Experiment Station, by H. J. Waters; Irrigation Experiments in Wisconsin, 1901, by F. H. King; Irrigation in New Jersey, 1901, by E. B. Voorhees; Second Progress Report on Silt Measurements, by J. C. Nagle.

Bulletin No. 133. Report of Irrigation Investigations for 1902. No. 1 contains: Irrigation in Mountain Water District, Salt Lake County, Utah, by E. R. Morgan; The Use of Water from the Wood Rivers, Idaho, by J. D. Stannard. No. 2 contains: Irrigation Investigations on Sand Creek, Albany County, Wyo., by B. P. Fleming; Irrigation in Washington, by O. L. Waller; Irrigation Investigations in Montana, 1902, by Samuel Fortier; Irrigation Systems on Stoney Creek, Cal., by W. T. Clarke and C. W. Landis; Irrigation in the Black Hills, S. Dak., by A. B. Crane. No. 3 contains: Rice Irrigation in Louisiana and Texas, by Frank Bond; Third Progress Report on Silt Measurements, by J. C. Nagle; Irrigation Experiments at Missouri Experiment Station, by H. J. Waters; Irrigation in Wisconsin in 1902, by A. R. Whitson; Irrigation Investigations in New Jersey, 1902, by E. B. Voorhees; The Use of Pumps for Irrigation in Hawaii, by Jared G. Smith.

New editions of bulletins were printed as follows:

Bulletin No. 86. That part of the Annual Report of Irrigation Investigations for 1899 referring to Utah.

Bulletin No. 92. The Reservoir System of the Cache la Poudre Valley, by E. S. Nettleton. Pp. 48, pls. 14. Price, 15 cents.

Bulletin No. 105. Irrigation in the United States. Testimony of Elwood Mead before the Industrial Commission June 11 and 12, 1901. Pp. 47. Price, 15 cents.

The following reports of work done in 1903 are now prepared and will soon be published:

Irrigation in Italy. By Elwood Mead. This is a report of observations made by Professor Mead in the valley of the Po in Italy during the summer of 1903. The climatic conditions in that valley are very similar to those in the central Mississippi Valley and the crops are the same, with a few exceptions. The report is therefore of especial value as showing what irrigation will do to increase production where

crops can be raised without it. Another important feature of the report is the description of the cooperative societies which the farmers have formed to control the distribution of their water supplies. These societies have very largely done away with the friction and controversy between neighbors and neighborhoods so common in this country. The Government exercises absolute control over streams and leases water instead of allowing the securing of perpetual rights like those in our Western States. The report also describes many of the irrigation works seen and the measuring devices examined.

Irrigation in the Valley of Lost River, Idaho. By A. E. Wright. This report deals with the peculiarities in the flow of Lost River and their influence upon the distribution of the water from the stream. The water of the river sinks and reappears below in the form of springs. This sinking makes it difficult to know the influence of diversions above the sink on the flow of the river below, and therefore complicates the work of the watermaster charged with the division of the water. Mr. Wright measured the stream at various points along 55 miles of its course, and the diversion from the same section, to determine where the water sinks and where it returns to the bed of the stream. These measurements will suggest to ditch owners how to locate their ditches to secure the largest supply from the stream.

Current Wheels. This report is a compilation of descriptions of wheels for raising water sent in by all the agents of the irrigation investigations. It gives drawings, half-tones, and detailed descriptions of a large number of wheels, with statements of the areas watered and the cost of construction.

NUTRITION INVESTIGATIONS AT THE GOVERNMENT HOSPITAL FOR THE INSANE, WASHINGTON, D. C.

By W. O. ATWATER, *Chief of Nutrition Investigations.*

Among the various reasons for careful attention to the food supply of an institution, two are of particular importance. In the first place, the comfort and well-being of the inmates depend in great measure upon their diet; and, in the second place, the cost of subsistence is usually a very large item in the expenses of the institution. Hence, any means of providing a more appropriate diet for the same expenditure, or for reducing the cost of the diet, provided it be otherwise satisfactory, is worthy of consideration.

As a result of extended inquiries in this country and elsewhere, which have been prosecuted with increasing activity in recent years, the general principles of nutrition are to-day fairly well understood, and it is now feasible to make practical application of the results of such inquiry to the improvement of the dietetic management of institutions. It is possible to determine with tolerable accuracy the physiological needs of the inmates for nourishment and, in the light of experience and experiment, it is apparent that the knowledge gained from a study of the diet with regard to the kinds, amounts, and costs of food, the methods of handling the supplies, and of preparing and serving the food will frequently show where and how improvements may be made so as to render the diet more attractive and palatable, and often better suited to the physiological demands of the persons nourished, while in many instances the cost may at the same time be very much reduced.

This is not meant to imply that it is impossible to provide a suitable diet for an individual or a group without considering the results of dietary studies and other similar investigations. Practical experience, as accumulated through many generations, has shown in a general way what amounts of food are required and what are satisfactory combinations. But it is coming to be more generally recognized that the results of scientific investigation are a helpful guide in the conducting of any enterprise. The proper feeding of individuals or groups is no exception to the general rule.

Having a very intelligent appreciation of such facts as these, the late Doctor A. B. Richardson, superintendent of the Government Hospital

for the Insane in Washington, requested the cooperation of the Office of Experiment Stations, in connection with its nutrition investigations, in a study of food economy of the institution under his charge. It was his desire to learn whether, as judged according to the best available knowledge, the diet of the hospital was properly suited to the needs of the employees and patients, and whether it was being supplied as economically as circumstances would warrant; or, if it was at fault in either respect, in what ways it might be improved. So far as the Office of Experiment Stations was concerned the opportunity to assist in such inquiry was considered especially advantageous, both as showing how the results of nutrition investigations may be put to practical use, and also for securing additional data for the establishment of dietary standards and other useful information regarding the dietetics of public institutions, requests for which are being continually received. That the importance of this subject is becoming more widely recognized is manifested by the inquiries that are being made and by the interest displayed by a large and increasing number of officers of public institutions and by public-spirited citizens.

PRINCIPLES GOVERNING THE PLANNING AND IMPROVING OF DIETARIES.

From the data obtained by experimental inquiry and from the facts learned by experience and observation in the feeding of large groups of people, several general principles may be deduced that must be considered both in the original planning and in the attempt to improve the diet of an institution. A certain amount of food is necessary for sustaining bodily functions, and this requirement, which is termed the physiological demand, varies with different conditions such as age, sex, health, muscular activity, environment, etc. The physiological demand forms the basis of the dietary standard, which may be expressed in amounts of food materials, or more conveniently in quantities of nutrients and energy, since the nutritive values of all food materials may be stated in these terms. The food supply of the institution must necessarily be larger than is required simply to meet the physiological demands of the inmates, since it is practically impossible to store, cook, and serve food without some loss from shrinkage and waste, the amount of food thus lost depending very largely upon its quality and upon the methods of storeroom, kitchen, and dining-room management. To provide adequately for the institution, therefore, the total food supply must be large enough to cover both the needs of the population and the losses from shrinkage and waste. The difference between food supply and food consumption, however, should not be unduly large, because when the former is too generous the kitchen and table wastes are likely to be excessive; and where food is served too abundantly there will also be a tendency to consume more food than

is required to maintain good physical condition which not only entails pecuniary loss, but also imposes unnecessary tax on the digestive functions and frequently impairs the health of the consumers. On the other hand, if the food supply is too limited and the shrinkage and waste are large, there is danger of underfeeding, which is more to be avoided than the opposite. Hygienic economy requires not only that the food shall meet the physiological demand in respect to the quantities of nutrients and energy, but also that it shall be suited to the digestive powers and other physiological peculiarities of the users. This is of special importance in the case of the aged and infirm and with invalids and young children. Pecuniary economy requires not only that there shall be a minimum of shrinkage and waste, but also that the food shall be such as to furnish the needed nutriment at the lowest cost consistent with the comfort and well-being of the persons fed. The attractiveness and palatability of the food should also receive due consideration, because often the adequacy of the diet as well as the happiness of the eater may be thus enhanced.

NATURE OF THE INQUIRY AT ST. ELIZABETHS.

The plan of investigation at St. Elizabeths comprehended an examination of the statistics of the food supply with regard to the kinds, amounts, and nutritive values of the materials; determinations by weighings and measurement of the amounts of food actually consumed by the different classes of the hospital population and of the amounts and kinds of dining room and kitchen wastes; observation of the methods of handling, cooking, and serving the food; experiments on the feeding of patients of different classes to determine their actual physiological needs and the best ways of supplying them without unnecessary waste; and, finally, learning how the proper officers and employees may be enabled not only to carry out but also to devise methods for improvement.

In an institution like a hospital for the insane, where there are so many different classes of patients, and especially in one where there are many different dining rooms and kitchens, to complete such an investigation as this would ordinarily require considerable time. Fortunately for rapid progress at the Government hospital, it was possible to make very satisfactory arrangements for the prosecution of the inquiry, and these were readily agreed to by Dr. Richardson, who thoroughly appreciated the requirements of the work. Mr. H. A. Pratt, who for several years had been associated with the work at Middletown, Conn., which forms part of the nutrition investigations of the Department of Agriculture, which are under the writer's direction, and with the dietary investigations made in the hospitals for the insane in the State of New York, also under the writer's direction, was given charge of the studies at St. Elizabeths. The data which he

collected were sent to Middletown to be calculated, tabulated, and classified there where there are facilities for such work and a force skilled in the performance of it. By this cooperation the results accomplished at the hospital during the past year are large and furnish a number of interesting and suggestive facts. At the same time the carrying on of the studies has not been in any way a burden or a drag upon the institution; it did not interfere in the least with the regular routine of the work, and the expense to the hospital was comparatively small.

The more important part of the investigations during the past year consisted of dietary studies in different wards and dining rooms. As a part of each study determinations were made of the amounts of different food materials brought into the kitchen and used in preparing the different meals, the amounts of the cooked foods sent to the dining room, the amounts served at the table, and those left uneaten, both on the plates and at the serving tables. Record was also kept of the number of persons at each meal during each study. This furnished data for the calculation of the quantities of nutrients and energy per person and per man in the food served, eaten, and rejected. Observations were also made of the methods of preparing, cooking, and serving the food, and of utilizing that which had been sent into the dining room but had not been served.

FOOD CONSUMPTION.

Twenty-seven such studies, each one week in duration, were completed; 23 with patients and 4 with employees. The total number of persons included approximately 1,600 male patients and 125 employees, both male and female. The data obtained were submitted to the Office of Experiment Stations for classification, tabulation, and calculation of results. In public institutions, as elsewhere, men eat more food and need more than women. The computations can be made "per man," "per woman," or "per person." All the studies of the patients at St. Elizabeths were made with men and the results are expressed "per man" per day. The studies with employees were with both men and women, but are computed on the "per man" basis, it being assumed that on the average a woman eats eight-tenths as much as a man. On this assumption the ratios per man, per person, per woman would be 10 : 9 : 8. The results of the experiments showed that on an average the food actually eaten by the patients furnished 93 grams of protein, 103 grams of fat, 361 grams of carbohydrates, and 2,705 calories of available energy per man per day. In a few of the wards the food consumption was somewhat lower than this, and in some it was higher; but in the majority of cases the variation of the individual studies from the average was not unusually wide. The results of the four studies with employees showed that they ate on an average 125

grams of protein, 164 grams of fat, 466 grams of carbohydrates, and 3,800 calories of energy per man per day. Considering patients and employees together, the average for the total number included in these studies was 97 grams of protein, 112 grams of fat, 377 grams of carbohydrates, and 2,870 calories of energy per man per day. This food consumption is large for people with the average muscular activity of the hospital population.

Whether these figures would represent the diet for the whole institution it is impossible to state with certainty, because there were several wards in which studies were not made; but, from a superficial observation of the patients and employees in these wards, it was believed that in respect to their physiological needs or actual food consumption they did not differ materially from those included in the studies. Since the number of persons included in the studies was rather more than half of the total population of the hospital and represented most or all of the different classes of patients and employees, it is probable that the average of the results obtained gives a fair indication of the conditions for the whole institution. A comparison of these results with those obtained in other institutions and with commonly accepted dietary standards indicates that the patients and employees at St. Elizabeths were certainly receiving adequate nourishment. In the extended series of investigations just mentioned as carried on in the New York State hospitals for the insane there was every indication that the population was abundantly fed; it was found that the food eaten averaged 73 grams of protein, 76 grams of fat, 317 grams of carbohydrates, and 2,305 calories of energy per man per day. The per capita ration allowance, to include both the food eaten and a loss of 15 per cent from shrinkage and waste, proposed on the basis of the results of these studies and the standard for food requirements of persons in health, was 100 grams of protein and 2,950 calories of energy. It is noticeable that the observed food consumption alone at St. Elizabeths was very nearly as large as this.

It would hardly seem that the requirements of the patients in this institution are larger than those of men at ordinary sedentary occupation, since the majority of them had no active employment. A commonly accepted dietary standard in this case calls for 100 grams of protein and 2,700 calories of energy. As shown by the figures given above, the food consumption of the patients was near enough to this to warrant the assumption that it was sufficient to meet their bodily needs.

The employees included in the studies comprised officers, clerks, ward and dining room attendants, waiters, and house girls. In respect to food requirements these may perhaps be compared with men at light to moderate muscular work, in which case a common dietary standard calls for 112 grams of protein and 3,040 calories of

energy per man per day. In comparison with this standard the four studies with attendants, the average for which is given above, would indicate that their diet was generous.

FOOD WASTE.

From the statistics of food purchased during the year ending just before these studies were begun it was calculated that the supply was sufficient to furnish the population for the year an average of 127 grams of protein, 172 grams of fat, 517 grams of carbohydrates, and 4,240 calories of energy per man per day. Similar figures were not obtained for the food purchased during the time of the studies, but from an examination of the accounts it seems fair to assume that the supply would differ but little from that of the preceding year in actual nutritive value. Assuming that there would be no difference in this respect, and that the average food consumption found in the dietary studies represents the condition for the total population, it would appear that between the purchase of the supplies and the serving of the food there is a loss of at least a fourth of the total amount. Part of this loss is of course due to shrinkage and deterioration in the storing and handling of the materials, but the larger part of it occurs in other ways. From the data collected in the dietary studies it was found that on an average the patients "wasted" 18 per cent of the total amount served to them and the attendants 22 per cent. This represents only the part of the food that was rejected at the plates and does not include the excess of food brought into the dining room over the amounts used to feed the individuals at the table. The latter made a small but appreciable proportion of the food sent from the kitchen to the dining room, and, being commonly too small to be returned to the kitchen and utilized in "made over" dishes, it usually went with the wastes from the plates, so that the total waste from the dining rooms would be even larger than the figures given. These results are considerably larger than have been observed elsewhere. In the studies in the New York hospitals for the insane the average table and kitchen waste was found to be 12 per cent.

To avoid misunderstanding, it may be explained that the term "waste" is here applied to material that is actually edible but is not utilized, such as bread, the flesh of meat, etc. Inedible material, such as bones, eggshells, skins, and seeds of vegetables, are considered as refuse, not as waste, and do not appear in these estimates. Of course, the waste is not an entire loss, because it is utilized to feed swine for pork. It is designated waste in the sense that it is not utilized as food for patients or attendants.

To one who has not looked into the matter, these figures for waste would seem surprising. It is quite probable, however, that in institutions where no special effort is made to prevent it, even so large a

difference between food supplied and food consumed as is implied in the data above compared is in the natural order of things. In the ordinary household it is comparatively easy to regulate the food supply so that it will not be materially in excess of what is actually eaten. The dietary habits of the different members of the family are known to the intelligent housewife. In economical families the food is selected and cooked in such ways as to meet the individual tastes and needs of the members without unnecessary waste in the kitchen. Each person selects the kinds and amounts desired, and the portions not used at one meal are saved and utilized again, so that little is wasted at the table. But even in private families and boarding houses, unless much care is exercised, the waste may be considerable. In a large number of dietary studies made in connection with the nutrition investigations of the Office of Experiment Stations it has ranged in private families from practically none to 8 or 10 per cent, and in boarding houses, even where economy was sought, it has averaged 10 per cent, and in some individual cases has reached 20 per cent, of the total food.

In large establishments, like hospitals for the insane, economy in dietary management is a more difficult matter than in ordinary families or boarding houses. The dining room and kitchen forces are smaller in proportion to the total number fed. In both the kitchen and the dining room, many of the employees lack training in the subject of proper utilization of food and have no incitement to economy, while frequently there are no conveniences or facilities for economizing. The leaks are more numerous and harder to stop, and the aggregate loss is much larger than would be realized without an examination of the statistics.

Waste can not be entirely avoided; more or less of it is inevitable; the best that can be done is to reduce it to a minimum. It is possible, even in large institutions, to provide for the utilization of food so that the losses shall be small. This can be accomplished by a better understanding of the nutritive values of food and of the demands of the people for nourishment, and by improvements in methods of storing, handling, and especially of preparing and serving the food.

In this way it will be possible to provide more palatable and more attractive nourishment at lower cost. This was demonstrated in the course of these studies. From time to time opportunities for improvement were pointed out to the late superintendent and were promptly acted upon by him; and he stated that in his opinion, as a result of these investigations, the cost of the food during the last six months of the year was lower than for any other corresponding period during his connection with the institution.

That a very material reduction in the amount of waste is possible is suggested by a study of the data showing the waste in the individual

studies. In many cases these were due largely to the fact that the menu was not entirely suited to the dietary habits or tastes of the persons partaking. In one study, for instance, the breakfast foods, meat stews, and leguminous soups were not relished, and from a fourth to a third of the oatmeal and nearly a half of the hominy served were wasted. That the diet in the case here pointed out was ample is evident from the fact that in spite of such large waste of individual foods the persons included in the study ate fully as much of nutrients and energy as in the average above given.

Similar facts were brought out in other studies. It would undoubtedly be possible to devise means for suiting the diet more nearly to the preferences and idiosyncrasies of the consumers in such cases, and at the same time effect a pecuniary saving. Such a condition has been observed in investigations made elsewhere. Prausnitz, a prominent German physiologist, in speaking especially of the diet of hospitals, has pointed out the fact that in order to be entirely satisfactory a diet must conform to previously acquired food habits. Mrs. Ellen H. Richards, in considering her studies of dietaries in institutions in Boston, has also observed that it is not enough to calculate the nutritive value of food and to have it cooked according to the best recipes and served in the most attractive manner; the food must have a familiar appearance and taste, because people prefer that to which they are accustomed. Novelty in food does not commend itself to those who have been used to little variety. In fact, for the most successful and economical feeding of persons in institutions, it is essential to consider their previous dietary habits.

On the other hand, monotony in the diet is also to be avoided. Where the menu repeats in weekly rotation, as is common in institutions, the patients associate certain days with certain diets and often acquire an aversion to the food as it is served. If less regular rotation of meals were provided it would undoubtedly add to the attractiveness of the diet.

The importance of the reduction of waste from a pecuniary standpoint is considerable. The cost of the food supplies at the Government hospital for the year 1901-2 was over \$178,000. If the percentage of waste found in these studies was true of the hospital in general, and if by improvement it should prove possible to reduce it by one-half, this would mean a saving of over \$20,000.

CONCLUSION.

So far as can be judged from the results of these studies as compared with similar data obtained elsewhere, the dietetic management of the institution was very satisfactory. Opportunities for improvement were observed, but these have to do with details rather than with the system as a whole. The diet was varied and attractive and certainly

abundant. On the whole the waste was larger than seems necessary, which would partially account for the fact that the cost of the diet was higher than would appear needful on theoretical grounds and higher than that of a similar diet in other institutions. With the knowledge of theoretical requirements and existing conditions it should be possible to provide an entirely satisfactory diet without unnecessary waste, and thus materially reduce the cost. What is necessary is first to learn the facts and then devise means for improvement. The studies made during the past year have given a tolerably clear idea of the existing conditions, and it is regarded as especially fortunate that during the present year it will be possible to make the attempt to improve them by applying the knowledge gained as the investigations at the Government Hospital are being continued with the cordial cooperation of Dr. W. A. White, the present head of the institution.

Of course the reduction of the cost is not the only object, nor even the chief object of such inquiry. Humanitarian considerations are of far higher consequence. Some of the inmates may be cured and everything possible should be done by diet or otherwise to facilitate their cure. Of the incurables a large proportion have a keen appreciation of the comforts and discomforts of their condition, and their sources of enjoyment are necessarily so restricted that with a large percentage the pleasures of eating are probably paramount. To alleviate their discomforts and to provide as much as possible of the things which contribute to their happiness is plainly a duty. But these ends may be served by fitting the food to the needs of the body and rendering the diet attractive and palatable. What is meant to be especially pointed out here is that, if this investigation is properly continued, it will be possible to learn much concerning the methods by which the food may be better adapted to the actual needs of the patients of the different classes, and to devise improvements in the planning of menus, and in the preparing and serving of the food which will fit it better to the varying tastes of the hospital population, and at the same time prevent unnecessary waste. The advantage will be threefold: it will help to make hospital life less wearisome to the patients, it will be hygienically beneficial, and it will tend to a better economizing of the food supply and thus reduce the cost. The effort involves expense, but the results will repay the cost many fold.

To fit the food to the physiological demand requires two things—that the food materials be such as will agree with the users, and that they supply the right proportions of nutrients and energy. What food best agrees with the user is found by actual experience. Generally speaking, the ordinary foods agree with ordinary people; exceptional cases have to be provided for as experience and good sense dictate. To find what proportions of nutrients are best adapted

to a given class of people is a matter of experiment. The common usage in institutions and in private life is for people to eat what they will of the food that is set before them. The proportions are frequently very far from those best suited to health, and often the pecuniary economy is even worse. What is wanted for public institutions is an extended series of carefully planned feeding experiments. These could be made at comparatively small cost; they need not be at all disagreeable or otherwise objectionable to the subjects, and the results would be of the greatest value. Much attention is now being given to the cooking and serving of food in public institutions, and with corresponding improvement. Combining this with physiological inquiry will bring the best results.

A SUMMARY OF RECENT AMERICAN WORK ON FEEDING STUFFS.

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The general subject of feeding stuffs, including composition, digestibility, feeding value, sophistication, manufacture, value for specific purposes, and related topics, has always received much attention at the hands of American investigators, especially those connected with the agricultural experiment stations. In recent years the amount of such work by station investigators has been materially increased by the fact that a number of States have laws regulating the manufacture and sale of feeding stuffs, and in the majority of cases the analytical work and other matters, necessitated by these laws, are intrusted to station officials.

In preparing the following summary of American work on feeding stuffs, published during the last three and a half years, the bulk of the data has been obtained from matter included or referred to in the Experiment Station Record, since in this journal all the experiment station literature is regularly noted and an attempt is made to include all other American work as well. In the case of many experiment station publications the date of distribution is difficult to determine and does not agree with the printed date of issue. It has been assumed, therefore, that any matter noted in the Experiment Station Record, Volumes XII to XIV, inclusive, and numbers 1 to 6 of Volume XV, that is, from September, 1900, to February, 1904, comes within the period which it is desired to cover. No account has been taken of the considerable number of short articles on the composition and value of feeding stuffs contributed to agricultural papers and other journals by experiment station authors. The amount of such material is large and, taken together, it represents a contribution to the subject which is of considerable importance from an educational and practical standpoint. Furthermore, mention has not been made of the considerable number of general discussions of feeding stuffs prepared by station officials and published in the station bulletins and reports, or those prepared in the Department of Agriculture and published as farmers' bulletins.

ANALYSES OF FEEDING STUFFS.

During the last few years the number of feeding stuffs analyzed in the United States has been very large. According to a careful estimate the total number of analyses published since July 31, 1900, is 11,749. Of these, 10,131 were made in connection with the inspection work carried on in a number of the States. The bulk of the analyses were reported by the State experiment stations. A considerable number, however, were published by the Bureau of Chemistry of the United States Department of Agriculture and the department of agriculture in one or two States, while a few have been reported from other sources.

The above statements do not take into account the comparatively large number of analyses of sugar beets and sorghum made in connection with sugar and sirup manufacture, nor those made for commercial reasons of potatoes, sweet potatoes, and skim milk; neither has account been taken of the analyses of some materials more often used as human foods though occasionally fed to farm animals, nor of the large number of ash analyses reported.

The following list will give an idea of the way the analytical work is distributed, though the classification followed is necessarily more or less arbitrary:

Analyses reported in the United States from September, 1900, to February, 1904.

Feeding stuff.	Num-ber.	Feeding stuff.	Num-ber.
Barley.....	3	Distillers' grains and similar products.....	62
Barley milling products.....	11	Beans, peas, peanuts, soy beans, and their milling products.....	74
Buckwheat.....	4	Mixed feeds, commercial and proprietary feeds, cereal breakfast-food by-products, and similar feeds.....	3,585
Buckwheat milling products.....	54	Poultry feeds.....	215
Corn.....	153	Condimental feeds.....	200
Corn milling products and feeds.....	691	Animal meals and similar products.....	207
Cotton seed and cotton-seed products.....	1,189	Forage crops, fresh and cured, including silage.....	798
Oats.....	28	Sugar-beet pulp and silage and other sugar-beet products.....	12
Oat milling products.....	51	Roots.....	47
Rice and rice milling products.....	23	Pumpkins and stock melons.....	11
Rye.....	18	Fruits, fruit pomace, etc.....	7
Rye milling products.....	36	Molasses, molasses feeds, and sugar.....	3
Spelt and spelt milling products.....	6	Miscellaneous.....	112
Sorghum seed.....	12		
Wheat.....	43		
Wheat milling products.....	1,875		
Gluten meals and feeds.....	1,233		
Flaxseed, linseed meal, and similar products.....	718		
Brewers' grains and malt sprouts.....	265	Total.....	11,749

As will be seen by the above list the number of analyses of wheat milling products, gluten products, and cotton seed and cotton-seed products is large. This is natural, since these goods are commercial by-products from important industries. The number of analyses of mixed feeds, commercial and proprietary feeds, cereal breakfast-food by-products, and similar feeds is also large. This is undoubtedly due

in a considerable measure to the great development of the cereal breakfast-food industry, as very many of these materials are by-products from the breakfast-food factories, and consist of shrunken or damaged grain, residues of the manufactured products and similar materials, often mixed with some standard concentrated feed, such as gluten meal.

A few analyses have been reported of materials seldom used as feeding stuffs, at least in the United States, including saltbushes, almond hulls, olive pomace, Russian thistles, corn silk, leaves of several varieties of oak and of poison oak, etc. No complete compilation of analyses of American feeding stuffs has been made in recent years, although a fairly complete summary^a of earlier analyses was issued some years ago. Several of the State experiment stations, following a common custom, have published more or less extended compilations within the last three years. Of these the bulletin by J. T. Willard^b published by the Kansas Station, entitled "The Exact Calculations of Balanced Rations," should be mentioned, since the feeding value of the different materials is summarized in a somewhat unusual way. According to the author, "the bulletin maintains and the method of calculation is based upon the fact that, reduced to a final analysis, the balancing of a ration consists in balancing the feeds used in it two by two. In this pairing any of the feeds may be used more than once, and the several quantities of a feed so used are finally added together to obtain the total sum. Recognition of the compound nature of this sum is essential to an understanding of the theory of the balancing of rations." The method of calculating balanced rations, on the basis of the protein, fat, and carbohydrate content is described, and a method suggested, regarded as ample for practical requirements, which takes into account only protein and nitrogenous constituents. In addition, a table is given which shows the relative amounts of a number of feeds, arranged in pairs, which may be used to approximate the nutritive ratios called for by the commonly accepted feeding standards. Figures are given for 14 different ratios. In the author's opinion "the mixtures given may in many cases constitute a ration; in others a ration may be compounded by using, in any proportion desired, any of the various mixtures having the same nutritive ratio."

The New Jersey Stations^c has published considerable data regarding the variations in price of commercial feeding stuffs during recent years.

^aCompilation of Analyses of American Feeding Stuffs, E. H. Jenkins and A. L. Winton, U. S. Dept. Agr., Office of Experiment Stations Bul. 11, 1892.

^bKansas Sta. Bul. 115.

^cNew Jersey Stas. Rpt. 1900, p. 180.

SPECIAL STUDIES OF FEEDING STUFFS.

A number of American investigators have published special studies dealing with different crops, grains, etc., which should be mentioned in a summary of the work on the general subject of feeding stuffs published during the period covered by this compilation.

At the Oregon Station, A. L. Knisely^a studied the composition of the different parts of the lupine plant.

J. Stewart,^b at the Utah Station, studied the composition of the different parts of the Golden Vine field pea, and H. K. Miller,^c of the Florida Station, studied the velvet bean.

C. D. Smith^d carried on an extended investigation at the Michigan Station of the shrinkage of oats, corn fodder and other corn products, and clover hay during storage.

At the Alabama Station, J. F. Duggar^e studied the composition of different parts of the cowpea plant.

C. H. Jones and B. O. White,^f at the Vermont Station, made special studies of the composition of the nitrogen-free extract matter of potatoes and artichokes.

Chemical studies of the changes in crops during the process of ensiling were made at the Oregon Station by J. Withycombe.^g

Work which is regarded as preliminary was carried on by J. Withycombe and A. L. Knisely,^h on treating corn fodders in silos with steam. The chemical composition of such silage was studied, as well as that of silage treated with salt with and without the addition of water, and silage which had received no special treatment.

F. S. Shiverⁱ has made an extended investigation of the composition of the Sea-island cotton plant and its parts. Numerous analyses were made of the seed, kernels, hulls, linters, lint, and meal of two varieties; the constants of Sea-island cotton-seed oil were determined, and the form in which phosphoric acid exists in the meal was studied. The investigations have also included determinations by the phenylhydrazin and phloroglucin methods of the pentosans in different parts of the plants. Pentosans were found to be widely distributed in the Sea-island cotton plant and its products, varying in amount from 1.53 per cent in lint to 21.88 per cent in the hulls.

J. T. Willard, R. W. Clothier, F. C. Weber, et al.,^j have reported numerous analyses of corn, made during a period of four years. The object of the work has been mainly to improve the protein content of corn, the results indicating that the most practical means for this pur-

^a Oregon Sta. Rpt. 1901, p. 30.

^b Utah Sta. Bul. 69.

^c Florida Sta. Bul. 60.

^d Michigan Sta. Bul. 191.

^e Alabama Sta. Bul. 118.

^f Vermont Sta. Rpt. 1901, pp. 209, 217.

^g Oregon Sta. Bul. 67.

^h Oregon Sta. Bul. 72.

ⁱ South Carolina Sta. Buls. 68 and 78.

^j Kansas Sta. Bul. 107.

pose is the selection of seed corn containing large germs. Extended crossing experiments have been conducted in connection with the chemical investigations.

An extended study of the corn kernel and the composition of its different parts has been carried on also at the Illinois Station by C. G. Hopkins and his associates.^a These investigations have for their chief object the modification and improvement of the corn kernel, with a view to increasing its protein content and its consequent value as a feeding stuff.

T. B. Osborne,^b at the Connecticut State Station, has continued his important investigations of the composition of proteids and has reported an extended study of the nucleic acid in the wheat embryo, the discovery of which is announced in the report of the station for 1899.

T. B. Osborne and I. F. Harris^c have also reported extended investigations of the form in which nitrogen occurs in proteids contained in feeding stuffs and some other materials, the specific rotation of some of these vegetable proteids, and other topics connected with the chemistry of this important group. (See also p. 522.)

The composition of different parts of the alfalfa plant at different stages of growth was reported by H. Snyder and J. A. Hummel^d at the Minnesota Station.

The feeding value of sorghum canes at different stages of growth, as shown by chemical composition, was studied by R. W. Thatcher^e at the Nebraska Station.

A special study of the composition of cotton-seed meal was reported by W. A. Withers and G. S. Fraps,^f of the North Carolina Station. In addition to the constituents usually determined, the authors report determinations of betain, cholin, gossypein, organic acids, and several members of the carbohydrate group. The pentosans of cotton-seed meal, they found, are not soluble in diastase, and are contained entirely in the nitrogen-free extract, unless an unusually large quantity of hulls is present. Cotton-seed meal was found to contain neither starch nor an appreciable quantity of sucrose or reducing sugars.

C. A. Browne, jr.,^g reported a chemical study of rice oil obtained from rice bran.

At the Montana Station, F. W. Traphagen^h concluded from a

^a Illinois Sta. Buls. 82 and 87.

^b Connecticut State Sta. Rpt. 1901, p. 365.

^c Jour. Amer. Chem. Soc., 25 (1903), Nos. 4, p. 323; 5, p. 474; 8, pp. 837, 842, 848, 853.

^d Minnesota Sta. Bul. 80.

^e Nebraska Sta. Bul. 62.

^f North Carolina Sta. Bul. 179.

^g Jour. Amer. Chem. Soc., 25 (1903), No. 9, p. 948.

^h Montana Sta. Rpt. 1902, p. 58.

number of analyses of grasses that, when the same species are gathered at different periods at different stages of growth, they may differ in composition to a greater degree than grasses of totally different genera collected under similar conditions.

R. W. Thatcher,^a of the Nebraska Station, analyzed a number of samples of different forage crops cut at an interval of three weeks, to study the effect of the time of cutting upon composition.

In connection with an investigation of the feeding value of bran, W. Frear and W. A. Hutchison^b studied the composition of bran from winter and spring wheat.

L. H. Merrill^c investigated the determined and calculated heat of combustion of feeding stuffs and the feces from sheep fed these materials. As an illustration of the discrepancies observed in the case of a number of samples of wheat and various milling products, the difference between the determination and the calculated fuel value ranged from 0.026 to 0.430 calories, or nearly 10 per cent of the total determined quantity. The variations, it is said, were intimately connected with the amount of crude fiber present.

In a discussion of feeding farm animals M. E. Jaffa and L. Anderson^d devoted considerable attention to the feeding value of fruits, summarizing a large amount of analytical data on this subject, most of which was derived from station analyses.

At the New Hampshire Station F. W. Morse^e carried on a special study of corn silage with reference to the amount of acidity developed by different varieties of corn preserved for different lengths of time.

Extensive microscopical studies of the anatomical structure of the seed of a number of cultural varieties of sorghum were carried on by A. L. Winton.^f

The same author^g reported similar studies of wheat screenings.

At the New Jersey Stations L. A. Voorhees and J. P. Street^h studied the losses in the fat of corn meal due to the action of molds. On the basis of a large number of analyses the fat in normal corn meal was found to average in amount 47 per cent as much as the protein. Samples which showed under the microscope the presence of *Penicillium glaucum* had lost from 4.2 to 67.7 per cent of the fat which should

^a Nebraska Sta. Rpt. 1900, p. 73.

^b Pennsylvania Sta. Bul. 48.

^c Maine Sta. Bul. 67.

^d California Sta. Bul. 132.

^e New Hampshire Sta. Bul. 96.

^f Ztschr. Untersuch. Nahr. u. Genussmtl., 6 (1903), p. 337; Connecticut State Sta. Rpt. 1902, pt. 3, p. 326.

^g Ztschr. Untersuch. Nahr. u. Genussmtl., 6 (1903), p. 432; Connecticut State Sta. Rpt. 1902, pt. 3, p. 339.

^h New Jersey Stas. Bul. 160.

have been present if the meals were originally of normal quality. To determine whether the growth of mold was the real cause of the diminished fat content, samples of normal corn meal of known composition were inoculated with *P. glaucum* and the mold allowed to grow for nine days at an average of 71° F., under different conditions as regards moisture. The percentage loss of fat was found to range from 1.35 to 12.24, the smallest loss being found in the sample in which there was 10.73 per cent of water present and greatest in the sample having the largest amount of water, viz, 36.24 per cent. In other words, this percentage loss of fat increases with the amount of moisture present. Other tests are very briefly reported, which bear out this opinion.

E. B. Hart and W. H. Andrews^a studied the form in which phosphorus occurs in feeding stuffs and animal by-products, reaching the conclusion that in such materials practically all the phosphorus occurs in organic compounds and that commercial feeding stuffs of vegetable origin do not contain appreciable quantities of phosphorus in inorganic compounds and, furthermore, that feeding stuffs of animal origin, such as liver meal and dried blood, are also approximately free from such phosphorus compounds.

The proportion of the energy of timothy hay available to the animal body was studied by H. P. Armsby and J. A. Fries^b at the Pennsylvania Station with a respiration calorimeter of the Atwater-Rosa type, which has been elaborated in cooperation with the Bureau of Animal Industry of this Department. In determinations of the income and outgo of energy in experiments with steers fed timothy hay, the following tentative conclusions were drawn:

The nutritive value of timothy hay, either for maintenance or production, was not measured in these experiments by its metabolizable energy, but was in every case materially less. In other words, the digestible nutrients of the timothy hay did not replace body tissue in isodynamic proportions.

The work of digestion and assimilation in the case of timothy hay appears to be so great that, at the maintenance requirement or even below it, the heat production of the animal is in excess of the amount needed for the maintenance of body temperature.

The availability of the metabolizable energy of timothy hay, within the range of these experiments, appears to be a linear function of its amount. The experiments afford no clear indication that the availability is less above the maintenance requirements than below it. (See also p. 535.)

Mention should be made of the extended compilation of data regarding the feeding value of sugar beets and sugar-beet products, published

^a New York State Sta. Bul. 238.

^b Proc. Soc. Prom. Agr. Sci., 1902, p. 96.

by L. S. Ware.^a This is not an experiment-station publication, but contains in addition to other data summaries of investigations carried on at a number of the stations on sugar beets, their composition, feeding value, etc.

ANALYTICAL METHODS.

In connection with the work referred to above much attention has necessarily been given to analytical methods. Any discussion of this subject must refer to the work of the Association of Official Agricultural Chemists,^b which has devoted much time to the consideration of methods of analyses.

In the report of the convention held in 1900 it was recommended by W. H. Krug, referee, on the basis of analyses of samples of wheat, bran, and peas, that the then method of the association for moisture be further studied, with the view of fixing the time required and the exact temperature at which the determination must be made. He also recommended further study of the effect of various methods of distillation on the result obtained by the phloroglucin method, and the determination of the effect of the length of time which the precipitated distillate stands upon the amount of phloroglucin obtained.

Recommendations were also made regarding the determination of pentosans and crude fiber by G. S. Fraps. Attention was called to probable sources of error in the official method of distillation in determining pentosans, in the quality of phloroglucin used, and in the composition of the products obtained by distillation of pentosans with hydrochloric acid. A method devised by König was proposed for preparing crude fiber practically free from pentosans. A method of purifying phloroglucin was adopted; also several changes in manipulation in the provisional method for the determination of pentosans by means of phloroglucin.

At the convention of 1901 the report of W. H. Krug, the referee on foods and feeding stuffs, related to the determination of moisture, starch, pentosans, and galactan. The recommendation of the referee dealt mainly with minor changes leading to more exact methods. It was recommended that the method used for drying sugars be adopted as optional for the drying of feeding stuffs. With the phloroglucin method it was recommended that, instead of using 3 grams of material, a quantity of the material be chosen so that the weight of the phloroglucin obtained shall not exceed 0.3 gram. A number of other minor modifications of this method were suggested.

A paper on the determination of pentosan-free crude fiber was pre-

^a Cattle Feeding with Sugar Beets, Sugar, Molasses, and Sugar-beet Residuum, by L. S. Ware, Philadelphia, 1902.

^b U. S. Dept. Agr., Bureau of Chemistry Buls. 46 rev., 62, 67, and 73.

sented by G. S. Fraps. The result of a test of König's method, with modifications, for determining pentosan-free crude fiber was reported. The method is found to be much shorter than the official one, the substance being digested, filtered, and washed in three hours. It has the following advantages: It yields a fiber practically free from pentosans, the manipulations are less complicated, and the time is shortened. It requires further study, however, in its application to cotton-seed meal. The author suggested that it be further studied by the referee.

The use of air in moisture determination, except in substances containing drying oils, was referred by the association to the referee for further study. In the diastase method for starch 20 cubic centimeters was adopted instead of 40 cubic centimeters in digesting with malt extract. In neutralizing, sodium hydrate in a cooled solution was adopted in lieu of sodium carbonate while hot. Instead of digesting over night with malt extract, two or three hours was considered sufficient. The recommendation for the phloroglucin method was adopted, and several other minor modifications were made. It was recommended that the referee take up the study of the König method for the determination of crude fiber.

At the convention of 1902, according to C. A. Browne, jr., referee of feeding stuffs, the work during the year was practically along the same lines as in the past and consisted mainly in the determination of the moisture, fat, and pentosans in samples of timothy hay and distillers' grains according to the official methods and in the comparison of the official and König methods for crude fiber on both samples. Based upon results obtained by nine analysts, the referee recommended a further study of the König method with the additional treatment of the fiber with alkali, as by the official method. The referee also recommended the substitution of Kröber's factors for calculating pentoses and pentosans for those given in the provisional method, which recommendation was adopted.

A paper by E. Gudeman, dealing with the manufacture and analysis of gluten feeds, was read. In this paper methods for the determination of fat and of the acidity were compared.

At the convention of official agricultural chemists held in 1903, F. D. Fuller^a reported the results of the official and the Dormeyer methods of estimating fat, the higher results being obtained by the latter method. The official method and the König method for estimating crude fiber were also studied.

C. A. Browne, jr.,^b at the same meeting, among other matters, reported the results of analyses of cattle feeds rich in protein. It was

^a Experiment Station Record XV, p. 435.

^b Experiment Station Record XV, p. 436.

found that when the residues from ordinary ether extraction were digested with pepsin additional quantities of fat were obtained by again extracting with ether.

Under special studies of analytical methods the following articles should also be mentioned:

R. W. Thatcher^a published an article dealing with filtration in the determination of crude fiber. He modifies the official method by filtering through asbestos wool, placed in a large funnel, on a platinum cone. The residue is washed into a platinum dish, the water evaporated, and the determination completed as usual. This procedure is especially adapted to the glycerol-sulphuric acid mixture used in the König method for crude fiber.

C. A. Browne, jr., and C. P. Beistle,^b in an article on the discrepancies in the analyses of feeding stuffs, studied pentosans and similar bodies, and G. S. Fraps^c studied the methods of estimating pentosans.

The nature, determination, and distribution of pentosans in Sea-island cotton was studied by F. S. Shiver,^d who compared the phenylhydrazin and phloroglucin methods of determination.

C. L. Penny^e devised a multiple fat extractor. An apparatus designed to overcome certain difficulties in determining fat was described by H. J. Wheeler and B. L. Hartwell.^f

F. G. Benedict^g proposed a modification of the method of distilling ammonia in the determination of nitrogen. The methods of determining proteid nitrogen in vegetable materials were critically studied by G. S. Fraps and J. A. Bizzell.^h

In continuation of earlier work on the constituents of proteids T. B. Osborneⁱ has reported important articles, including (1) an investigation on the hydrolytic derivative of the globulin edestin and its relation to Weyl's albuminate and the histon group, (2) the basic character of the protein molecule and the reactions of edestin with definite quantities of acids and alkalis, and (3) a study of sulphur in protein bodies. -(See also p. 517.)

E. Gudeman^j studied the determination of fat and acidity in gluten feeds. He found that drying corn gluten feeds in hydrogen, vacuum, or air modifies them sufficiently to give low results for the percentage

^a Jour. Amer. Chem. Soc., 24 (1902), p. 1210.

^b Jour. Amer. Chem. Soc., 23 (1901), p. 229.

^c Amer. Chem. Jour., 25 (1901), p. 501.

^d South Carolina Sta. Bul. 78.

^e Delaware Sta. Rpt. 1900, p. 85.

^f Rhode Island Sta. Rpt. 1901, p. 268.

^g Jour. Amer. Chem. Soc., 22 (1900), p. 259.

^h North Carolina Sta. Bul. 174.

ⁱ Connecticut State Sta. Rpt. 1900, pt. 4., pp. 388-471.

^j Science, n. ser., 16 (1902), p. 287.

of fat and increases the acidity of the extracted fat. The author claims that acidity of feeding stuffs is due to the presence of acid salts and is no criterion of the quality of the feed or raw materials from which it was made.

The determination of sulphur and chlorine in plants was studied by G. S. Fraps,^a and determinations of the sulphur content of a number of vegetable materials were reported by the author and W. A. Withers.^b

The determination of pentosan-free crude fiber was studied by G. S. Fraps.^c

MANUFACTURE OF FEEDING STUFFS.

In their publications on the composition and value of feeding stuffs a number of the stations have discussed the processes of manufacture. Thus, J. B. Lindsey,^d at the Massachusetts Station, described the manufacture of concentrated feeds, and at the Pennsylvania Station W. Frear^e described the processes of manufacture of commercial feeds. At the Iowa station W. J. Kennedy and F. W. Marshall^f described the processes of manufacture of tankage and similar materials which are assuming some importance at the present time as a stock feed.

CONDIMENTAL AND MEDICINAL FEEDS.

A large number of condimental and medicinal feeds are on sale in the United States. Several of the State experiment stations have analyzed such goods and have studied their value in proportion to their cost and as compared with the claims made for them by the manufacturers. The work published during the period covered by this summary includes series of analyses by F. W. Woll,^g W. H. Jordan and C. G. Jenter,^h by the Connecticut State Station,ⁱ L. A. Voorhees and J. P. Street,^j R. J. Davidson,^k E. H. Jenkins et al.,^l W. Frear,^m B. W. Kilgore,ⁿ and J. B. Lindsey.^o The general con-

^a North Carolina Sta. Rpt. 1902, pp. 42, 44.

^b North Carolina Sta. Rpt. 1902, p. 53.

^c North Carolina Sta. Rpt. 1902, p. 59.

^d Massachusetts Sta. Bul. 78.

^e Pennsylvania Dept. Agr. Rpt. 1901, pt. 1, p. 559.

^f Iowa Sta. Bul. 65.

^g Wisconsin Sta. Rpt. 1899, p. 271.

^h New York State Sta. Bul. 166.

ⁱ Connecticut State Sta. Bul. 132. Conn. Sta. Rpts. 1900, p. 355; 1902, p. 359.

^j New Jersey Sta. Bul. 153.

^k Virginia Sta. Bul. 107.

^l Connecticut State Sta. Rpt. 1901, pt. 4, p. 313.

^m Pennsylvania Sta. Rpt. 1901, p. 28. Pennsylvania Dept. Agr. Bul. 107.

ⁿ North Carolina Dept. Agr. Bul. 24 (1903), No. 1, p. 78.

^o Massachusetts Sta. Bul. 71.

clusion reached is that these materials consist of mixtures of such common drugs as gentian, fenugreek, salt, sulphur, charcoal, sulphate of magnesia, soda, etc., mixed with cereals, oil meal, and by-products. The cost of such goods is very high in proportion to their nutritive value, and the general opinion seems to be that as remedial agents they are not needed by healthy animals.

R. W. Clothier^a reported the composition of condimental stock food and also a test in which a lot of 211 sheep fed alfalfa hay and ear corn gained 117 pounds more than a similar lot fed condimental stock food in addition to the hay and corn.

C. S. Plumb^b tested the value of condimental stock food in fattening swine. In one test the best results were obtained without condimental feed, and in another somewhat greater profits were obtained with a lot fed this material. Discussing these experiments the author states, "In themselves there is no special objection to stock foods. In fact, there are brands made that are rich in nutriment and have a high value as a food. The principal criticism that can be made is the excessive price generally charged for them, which is far beyond their value. No doubt in many cases oil meal will give fully as satisfactory results as the stock food."

H. Snyder and J. A. Hummel^c found that steers digested alfalfa hay fed with corn meal much more thoroughly than a similar ration with the addition of condimental food.

At the Virginia Station D. O. Nourse and M. Ferguson^d examined a considerable number of condimental feeds and found that they were made up of ordinary concentrated feeds and such drugs as Epsom salts, sulphur, ginger root, fennel seed, gentian, fenugreek, mustard, etc. These drugs are used in small quantities so the price per ton would not greatly exceed that of the concentrated feed used as a base, probably not over \$40 per ton, "while the price to the consumer is from \$140 to \$1,600 per ton.

"If at any time the animal begins to show improvement, apparently from the use of these powders, it can be attributed rather to the better care and treatment which the animal in nearly every case receives than to any particular virtue contained in the prepared articles. It is noticeable that in nearly all cases they are recommended to be fed with a mash feed of some kind."

The feeding value of fenugreek, which is an ingredient of many condimental stock foods, is discussed in a recent journal.^e

^aIndustrialist, 26 (1900), p. 469.

^bIndiana Sta. Bul. 93.

^cMinnesota Sta. Bul. 80.

^dVirginia Sta. Bul. 144.

^eFarm Students' Rev., 7 (1902), p. 21.

POISONOUS PLANTS AND INJURIOUS FEEDING STUFFS.

The number of farm animals annually injured or killed by eating poisonous plants is fairly large. The American investigators have devoted considerable attention to the study of these materials, which quite commonly form a part of pasture grasses or cured forage crops. A summary of the work along these lines, published during the time covered by this summary, should include the following:

The Nebraska Station Report for 1899 contains notes by C. E. Bessey^a on various poisonous plants growing in that State.

At the Montana Station E. V. Wilcox^b published a list of plants which were known to be poisonous, or which were suspected of being injurious to stock. Of the species mentioned, the purple and tall larkspur, aconite, lupine, death camass, nightshade, and water hemlock are known to have caused the death of a number of animals, while loco weeds are suspected of being injurious. Cases of poisoning by lupines were investigated, and it was found that the most severe losses have been due to eating these plants in the form of hay, the poisoning in all cases being apparently due to eating the ripe or nearly ripe seed. The bulletin also contains an account of the poisoning of cows by feeding smutty-oat hay and a study of poisoning believed to be caused by ergot growing on native grasses.

D. A. Brodie,^c at the Washington Station, carried on a number of experiments with *Eranthis surmentosa*, *Angelica geniculata*, *A. hendersonii*, *Stium cicutifolium*, *Heracleum lanatum*, *Conioselinum gmelini*, which indicated that these plants were not poisonous. Death or serious symptoms of poisoning were observed when steers were fed fresh new roots of *Cicuta vagans*, although neither the young plant nor the mature plant, including roots, proved poisonous. No bad effects were observed when cured *Cicuta vagans* found in hay was fed to steers.

The Division of Botany of the United States Department of Agriculture published an extended report by V. K. Chesnut and E. V. Wilcox^d on the stock-poisoning plants of Montana. The most important of these are considered to be *Zygadenus venenosus*, *Delphinium glaucum*, *D. bicolor*, *Cicuta occidentalis*, *Aragallus spicatus*, *A. lagopus*, *A. splendens*, *Lupinus leucophyllus*, *L. sericeus*, and *L. cyanus*.

A number of experiments were made in the treatment of poisoned animals, sheep, cattle, and rabbits, and especially promising results were obtained from the use of permanganate of potash as an oxidizing agent, administered as soon as possible after symptoms of poisoning were manifested.

^a Nebraska Sta. Rpt. 1899, p. 28.

^b Montana Sta. Bul. 22.

^c Washington Sta. Bul. 45.

^d U. S. Dept. Agr., Division of Botany Bul. 26.

V. K. Chesnut^a published considerable data on the poisonous plants of the stock ranges of the northern United States, the discussion being partly based on the bulletin referred to above.

According to recent experiments at the Vermont Station^b the common horsetail (*Equisetum arvense*) may cause poisoning when present in hay. It was found that when horses were fed cured horsetail equal in amount to not more than one-fourth of their coarse-fodder ration symptoms of poisoning were noticed and, if the feeding was continued, the horses died. The symptoms of poisoning were less noticeable with young than with old horses, and also when a liberal grain ration was supplied. It was also observed that the green plant was less harmful than the dry, possibly owing to the fact that green fodder is somewhat laxative. The experiments were made by F. A. Rich and L. R. Jones.

An important contribution to the subject of injurious feeding stuffs has been made by A. T. Peters, S. Avery, and H. B. Slade^c of the Nebraska Station, who have for a number of years studied sorghum poisoning and have recently demonstrated the presence of cyanic acid in the green leaves of young and old sorghum plants and Kafir corn.

The poison, it is stated, is always present in at least minute traces, but becomes dangerous only when the plant is arrested by dry weather at certain stages of its growth. Sunlight such as prevails in the arid and semiarid parts of the United States causes the development of the poison in excess. When the symptoms of poisoning do not appear so violently as to make medical treatment out of the question, drenching the animal with a solution of corn sirup or with sweet milk is suggested. Thoroughly cured Kafir corn that had been especially deadly before harvesting was fed without producing any symptoms of poisoning.

Experiments to study the cause of the injurious effects of cotton-seed meal were carried on with pigs by R. R. Dinwiddie,^d which furnished considerable information regarding the length of time which small amounts of cotton-seed meal may be fed, symptoms of poisoning induced by larger amounts, and related topics, but did not show definitely to what the poisonous effects were due.

FEEDING-STUFFS INSPECTIONS.

Although the experiment stations had from the first analyzed quite generally the feeding stuffs found in the markets and called attention to the variation in their composition and the effect of this upon their real value, there was no inspection and control of concentrated feeding stuffs under law in the United States until 1897.

^a U. S. Dept. Agr. Yearbook 1900, p. 305.

^b Vermont Sta. Bul. 95.

^c Nebraska Sta. Rpt. 1901, pp. 50, 55; Bul. 77. Jour. Comp. Med. and Vet. Arch., 23 (1902), p. 704; Jour. Amer. Chem. Soc., 25 (1903), p. 55.

^d Arkansas Sta. Bul. 76.

In that year the legislature of Massachusetts passed an act authorizing the experiment station to sample and analyze for protein and fat all concentrated commercial feeding stuffs offered for sale in the State and to publish the results, "with such additional information as circumstances advise," omitting the names of the jobbers or local dealers selling the feeding stuffs. The law directs that the samples shall be taken from packages representing not less than 5 per cent of the whole lot inspected, and each sample divided into two equal parts, properly labeled, one duplicate to be retained by the party whose stock is sampled and the other used by the station for analysis. No provision is made by this law for a guaranty of the composition of feeding stuffs and no penalty for selling inferior goods. However, through the influence of the station a considerable number of large manufacturers and jobbers have been led to place guaranties upon their goods, and intelligent farmers have been aroused to the desirability of buying feeding stuffs only on guaranty.

The same year (1897) the State of Maine enacted a law for the inspection of feeding stuffs much more comprehensive in its character, and this law has served as the basis of laws since passed by several other States.

The concentrated feeding stuffs coming within the scope of the Maine law include linseed meals, cotton-seed meals, pea meals, coconut meals, gluten meals, gluten feeds, maize feeds, starch feeds, sugar feeds, dried brewers' grains, malt sprouts, hominy feeds, cerealine feeds, rice meals, oat feeds, maize and oat chops, ground beef or fish scraps, mixed feeds, and all other material of similar nature, not including hays and straws, the whole seeds or unmixed meals made directly from the entire grains of wheat, rye, barley, oats, maize, buckwheat, and broom corn, or wheat, rye, and buckwheat bran or middlings.

The concentrated feeding stuffs as defined are required to bear a label stating the number of net pounds in the package, the name or trade-mark of the material, name and address of the manufacturer or shipper, and the percentage of crude protein and of crude fat, as determined by the methods adopted at the time by the Association of Official Agricultural Chemists. Before offering a concentrated feeding stuff for sale in the State, the manufacturer or dealer must file with the director of the Maine Experiment Station a certified copy of the label to be used on each brand, accompanied, when requested, by a certified sample of the feeding stuff. This is not required of local dealers when the manufacturer or importer has complied with the laws, otherwise the local dealers are liable. An inspection tax of 10 cents per ton is to be paid to the director of the Maine Station, who in return furnishes tags to be affixed to each package stating that the specified charges have been paid. The inspection taxes received by

the director are paid over to the treasurer of the Maine Station, who is required to make an annual report of receipts and expenditures from the fund, and to turn over to the State treasury all receipts in excess of \$3,000 per annum.

The inspection is conducted by the director of the station, who is authorized to take samples in person, or by deputy, not exceeding 2 pounds in weight, from any lot or package of concentrated commercial feeding stuffs which may be in the possession of any manufacturer, importer, or dealer in the State, the sample to be drawn in the presence of a representative of the dealer. The mixed sample is divided into two equal parts, properly labeled, and one part taken for the inspection, while the other is retained by the dealer. The results of the inspection are published in reports or bulletins from time to time.

Failure to comply with the provisions of the law is punishable by a fine of not more than \$100 for the first offense and not more than \$200 for each subsequent offense. The secretary of the State board of agriculture is made the prosecuting officer under the law, being notified of any violation of its provisions by the director of the experiment station. Upon learning of violations of the act the secretary is required to notify the manufacturer, importer, or dealer and give him not less than thirty days in which to comply with the requirements of the act. No prosecution relative to the quality of concentrated feeding stuff is to be made if the same is found substantially equivalent to the guaranty. This law went into effect October 1, 1897.

The Vermont law, which is modeled on the Maine law, was passed in 1898 and went into effect July 1, 1899. It differs from the Maine law in some minor details. It charges the director of the Vermont Experiment Station with the carrying out of the law and the inspection in practically the same manner as the Maine law. It provides that the percentage of crude fat need not be guaranteed when it is less than 3 per cent. To facilitate the inspection the law requires that all manufacturers and importers of concentrated commercial feeding stuffs shall, upon request, furnish the director of the station with a complete list of the brands of feeding stuffs which they sell in the State, and the names of their agents.

The inspection tax received by the director is to be paid to the State treasurer, and from this the station is to be reimbursed for the expense of carrying out the inspection, in no case in excess of the amount of inspection tax received.

The penalty for noncompliance with the law is fixed at \$50 for the first offense and not more than \$100 for each subsequent offense. The director notifies the State treasurer of all violations of the act and the latter institutes the prosecution.

The laws of Connecticut and Rhode Island, both of which went into effect July 1, 1899, are almost exactly alike and are both quite similar

to the Maine law. The Connecticut law includes in its scope brans and middlings, although State inspection laws generally exempt these materials. Neither the Connecticut nor Rhode Island law imposes an inspection tax. The Connecticut law makes no provision of funds for its execution, but the Rhode Island law carries an appropriation of \$1,300 per annum for that purpose. Both laws provide the same penalty as the Maine law, prosecution under the law being in the hands of the State dairy commissioner in the case of the Connecticut law and the board of managers of the Rhode Island College of Agriculture and Mechanic Arts in the case of Rhode Island.

February 13, 1899, the North Carolina general assembly passed what is known as the "pure food law," which went into effect on August 1 of the same year. Under this law feeding stuffs are analyzed as well as foods, since the law declares that the term "food" shall include all articles used by man or domestic animals for food, condiments, or drink, whether simple, mixed, or compound.

The State board of agriculture is intrusted with the carrying out of the provisions of the law and is authorized to collect samples, make examinations, and publish the results; to cause all compound, mixed, or blended products to be properly branded; to describe how this shall be done; to fix standards of strength, quality, and purity, and to publish lists of articles exempt from the provisions of the act. When adulteration, misbranding, or other violation is evident, the board of agriculture is directed to certify the fact to the proper solicitor, who shall prosecute without delay in every case.

The law provides that any person who shall knowingly manufacture, sell, expose for sale, or have in his possession with intent to sell any article of food which is adulterated or misbranded, or who shall violate any of the provisions of the act, shall be guilty of a misdemeanor and be fined not to exceed \$200 for the first offense and for each subsequent offense not exceeding \$300, or be imprisoned not exceeding one year, or both.

The law also provides for the purchase of samples for analysis, and failure to comply with this provision or hindering the work of the State chemist is declared a misdemeanor, punishable by fine of not more than \$100 or by imprisonment for not more than 100 days, or both.

All fines, less legal costs and charges, shall be paid into the treasury of the State for the benefit of the department of agriculture, to be used exclusively in executing the provisions of the pure-food law.

The New York law, which went into effect December 1, 1899, is likewise very similar to the Maine law in its general provisions, but differs in requiring a license fee of \$25 annually by each manufacturer, importer, or dealer. These license fees are transmitted by the director of the station to the State treasurer, and are used in defray-

ing the expense of the inspection and in enforcing the provisions of the law. The penalty for failure to comply with the provisions of the law is the same as in the case of the Maine law, and is enforced by the State commissioner of agriculture.

A clause relating to adulteration of meal or ground grain with milling or manufacturing offals is added, providing that such adulteration, unless plainly marked or indicated upon the package, shall be punishable by a fine of not less than \$25 nor more than \$100 for each offense.

The New Jersey Station from time to time voluntarily made quite comprehensive studies of different classes of concentrated feeding stuffs, showing the variation in percentage composition and in relative price. The legislature on March 15, 1900, passed a law regulating the sale of feeding stuffs in New Jersey, which is very similar in its provision to the Maine law. The experiment station is authorized to secure the collection of samples of every kind of material used for feeding domestic animals, to analyze them, and to publish the results. Penalties varying from \$25 to \$200 are provided for violating the provisions of the law.

On April 5, 1900, Maryland adopted a feeding-stuff law regulating the manufacture and sale of concentrated feeds, the law being similar in many respects to that of North Carolina. The State chemist of the Maryland Agricultural College is required to collect and analyze samples, and the manufacturer, importer, agent, or seller of the feeding stuff is required to pay to the treasurer of the agricultural college an inspection fee of \$20 for each brand, and shall receive from the treasurer a license. Failure to comply with the law carries a penalty of \$100 to \$500, or, under certain conditions, imprisonment of not less than one or more than six months, or both fine and imprisonment.

The Pennsylvania legislature passed a feeding-stuff law April 25, 1901, which went into effect on the 1st day of October of the same year. The State secretary of agriculture is intrusted with carrying out the provisions of the law, the necessary expenses being paid out of the State treasury, the maximum amount which may be expended being not more than \$5,000 a year. Failure to comply with the law carries a penalty of \$50 to \$100 and costs, including expenses of analysis under certain conditions, with the alternative of from ten to thirty days' imprisonment in certain cases, or both fine and imprisonment.

May 13, 1901, the Wisconsin legislature passed a law, which went into effect July 1 of that year, regulating the sale and analysis of concentrated feeding stuffs, which is also similar to the Maine law. The director of the State experiment station is required to analyze or cause to be analyzed at least one sample of every concentrated feeding stuff sold or offered for sale under the law. The penalties provided for violating the law range from \$25 to \$200.

The New Hampshire legislature passed a law regulating the sale of

concentrated feeding stuffs in 1901, which went into effect December 1 of that year. The law requires that each manufacturer, importer, agent, or seller of any concentrated commercial feeding stuff shall pay annually to the State a license fee of \$20. The secretary of the State board of agriculture is instructed to have analyses of the feeding stuffs offered for sale made at the State station. Selling or attempting to sell any commercial feeding stuff without complying with the requirements is punishable by a fine of not more than \$100 for the first offense and not more than \$200 for each subsequent offense. "Any person who shall adulterate any kind of meal or ground grain with milling or manufacturing offals, or any other substance whatever, for the purpose of sale," without stating the fact plainly, or who shall sell, or attempt to dispose of such goods, unless their true character is indicated, shall be fined not less than \$25 nor more than \$100 for each offense. The carrying out of the provisions of the law is intrusted to the State board of agriculture, acting through its secretary, and the State experiment station.

For a time the Tennessee Station conducted an inspection of cottonseed meals, though such inspection has not been required by State law.

In all the States having feeding stuff control laws publications are issued from time to time, giving the text of the laws and results of analyses of feeding stuffs, lists of feeding stuffs on sale with guaranteed composition, and similar data. In those States in which the carrying on of the laws is intrusted to the experiment stations, these publications are issued as station bulletins or are included in the annual reports.

In general it may be said that the laws providing for feeding-stuff inspection have accomplished a great amount of good in diminishing the sale of worthless materials, instructing the people in regard to the composition of feeding stuffs and their comparative value, and at the same time promoting the interests of honest manufacturers and dealers.

ADULTERATION OF FEEDING STUFFS.

The inspection work carried on in the United States necessarily involves the examination of feeding stuffs with a view to the detection of adulteration or sophistication, and, as has been previously noted, such legislation has in general resulted in the sale of concentrated feeds which are free from adulteration in States with a feeding-stuff law.

In a recent publication of the New Jersey Stations, L. A. Voorhees and J. P. Street^a described two materials which are new adulterants in the New Jersey feed markets. One consisted of the hard, flinty hulls of the rice grain and has been sold under the misleading name

^a New Jersey Stas. Bul. 160.

of "rice meal." The other consisted of the entire hull of the coffee berry and has been sold under the misleading name of "cornaline."

J. B. Lindsey^a published data regarding the extent of feeding-stuff adulteration in Massachusetts, and mentioned new feeds which had been placed on the market.

FEEDING EXPERIMENTS.

Generally speaking, the feeding experiments with farm animals in the United States have been conducted at the experiment stations. The feeding stuffs and rations tested and the problems studied are very varied. The number of experiments published during the period covered by this compilation is fairly large, and any adequate summary of the work would be too long for the purposes of this paper. The following table, which shows the number of publications reporting such experiments issued by the stations, gives an idea of the scope of the work:

Number of publications reporting feeding experiments made with different farm animals.

Stations.	Calves.	Cattle and steers.	Chickens.	Cows.	Horses and mules.	Pigs.	Sheep and lambs.	Turkeys.
Alabama College Station				3		1		
Arizona Station		2		1			1	
Arkansas Station						2		
California Station						1		
Colorado Station		1		1		1	2	
Connecticut State Station				1				
Connecticut Storrs Station				1				
Florida Station		2				2		
Georgia Station				1				
Idaho Station		2					1	
Illinois Station	1	2		1				
Indiana Station						4		
Iowa Station		2				2	3	
Kansas Station	2	4				1		
Kentucky Station		1		1		1		
Louisiana Station					1			
Maine Station			3					
Maryland Station				2		1		
Massachusetts Station			3		1			
Michigan Station		1		1				
Minnesota Station		1		3		1	1	
Mississippi Station		2		4	1		1	
Missouri Station	1	4				1		
Montana Station		5	2	1	1	3	6	
Nebraska Station	4	2		2		2	2	
Nevada Station		1				1		
New Hampshire Station					1			
New Jersey Stations				6				
New York Cornell Station			1	1		1	1	
New York State Station			1	2				
North Dakota Station					1			
Oklahoma Station		3				3		
Oregon Station						1	1	
Pennsylvania Station	2	4		4			1	
Rhode Island Station			1	1				
South Carolina Station			1	1		1		1
South Dakota Station							3	
Tennessee Station		2		1		1		
Utah Station		1	1	1	1	1	2	
Vermont Station				11				
Virginia Station		1				1		
Washington Station								
Wisconsin Station				2		13	4	
West Virginia Station		1	3				1	
Wyoming Station				1	2		2	
Total	10	44	16	56	8	46	32	1

^a Massachusetts Sta. Rpt. 1902, p. 52.

A few feeding experiments have been carried on by American investigators not connected with experiment stations, thus Margaret B. Wilson^a studied the growth of suckling pigs fed on a diet of skimmed cow's milk.

Several investigators have reported more or less extended data regarding the feeding value of molasses for horses; for instance, G. H. Berns^b reported tests in which molasses was successfully employed as a part of the ration for a large number of horses for a considerable time.

A number of the stations have published general discussions of feeding problems and summaries of the results obtained. A number of textbooks and other treatises discussing the subject have also been issued. Several publications have been prepared by American authors which discuss the feeding of squabs and pigeons and quails in captivity on the basis of personal experience.

The following works by station officials dealing with the general subject of feeding should be mentioned: *The Feeding of Animals*, by W. H. Jordan; New York, 1901. *Feeds and Feeding*, fourth edition, by W. A. Henry; Madison, Wis., 1902. *The Principles of Animal Nutrition*, by H. P. Armsby; New York, 1903. *The Chemistry of Plant and Animal Life*, by H. Snyder; Easton, Pa., 1903.

DIGESTIBILITY OF FEEDING STUFFS.

At about the date stated as the beginning of the period covered by this summary, a bulletin was published by W. H. Jordan and F. H. Hall,^c summarizing the American digestion experiments with farm animals, exclusive of poultry. Since that time a number of the stations have issued bulletins discussing the subject and have published more or less complete summaries of coefficients of digestibility. One of these by J. B. Lindsey and N. J. Hunting,^d of the Massachusetts Station, contains a reasonably complete summary of the American work, including the results of the experiments with ruminants, swine, horses, and poultry. A summary of digestion experiments with sheep carried on at the Massachusetts Station was recently published by J. B. Lindsey et al.^e

The experiments on the digestibility of different feeding stuffs published during the period under consideration include the following:

The digestibility of Kafir corn, maize, and cowpeas, ground and unground, was tested with chickens by J. Fields and A. G. Ford.^f

H. Snyder and J. A. Hummel^g studied the digestibility of hog-millet seed with a pig, finding that this material is equal in digestibility to

^a Amer. Jour. Physiol., 8 (1902), No. 3, p. 197.

^b Amer. Vet. Rev., 26 (1902), p. 615.

^c U. S. Dept. Agr., Office of Experiment Stations Bul. 77.

^d Massachusetts Sta. Rpt. 1901, p. 195.

^e Massachusetts Sta. Rpt. 1902, p. 82.

^f Oklahoma Sta. Bul. 46.

^g Minnesota Sta. Bul. 80.

barley, wheat, and shorts, but is inferior to corn meal or oil meal. The experiment is interesting, since the method of separating the feces was the same as that commonly used in experiments with man, namely, charcoal was given with the last meal before and the first after the test. This imparts a characteristic color to the feces.

W. H. Jordan and C. G. Jenter^a studied with sheep the digestibility of commercial oat feed when added to a grain ration.

The digestibility of some of the nonnitrogenous constituents of a number of feeding stuffs was tested by G. S. Fraps^b in experiments with sheep, the materials studied including timothy hay, green rape, crab-grass hay fed alone and with cowpea meal, and corn bran and rice bran. The constituents studied included the different members of the carbohydrate group. According to the author the constituents which make the nitrogen-free extract should be arranged in the following order as regards digestibility: Sugar, starch, pentosans, and "remainder." The crude fiber he divides into pseudo-pentosans and residue, the former making up from 0 to 14.4 per cent of the crude fiber, and being as a rule less digestible.

J. Fields and A. G. Ford^c studied the digestibility of a number of coarse fodders with sheep, the different sorts of forage including Kafir corn, corn, sorghum, black-rice corn, and milo maize.

J. M. Bartlett^d studied with sheep the digestibility of clover hay, clover silage, corn meal fed with clover hay, hay (mostly timothy), oats, oat and pea hay and silage, oat and vetch hay, two mixed feeds, and corn germ.

In experiments with sheep J. B. Lindsey^e studied the digestibility of millet, millet hay, millet and soy-bean silage, corn and soy-bean silage, hay (largely June grasses), meadow fescue, Kentucky blue grass, tall-oat grass, distillery grains, oat feed, rye feed, Cleveland flax meal, and a commercial feed.

In an extended investigation of the amount of feed required by sheep for a maintenance ration, W. W. Cook^f studied the digestibility of timothy hay alone and fed with corn.

C. G. Hopkins^g studied with steers the digestibility of corn fodder (ground corn and cobs and shredded stover) and shredded corn stover. He found that the value of the material was increased by grinding and shredding, shredded corn stover closely resembling timothy hay in composition and digestibility.

H. E. Stockbridge,^h in experiments with steers, studied the digestibility of cassava fed with cotton-seed hulls and cotton-seed meal.

In a digestion experiment with steers made by H. K. Millerⁱ the digestibility of green velvet bean vines and hay was studied.

^a New York State Sta. Bul. 166.

^b North Carolina Sta. Bul. 172.

^c Oklahoma Sta. Bul. 46.

^d Maine Sta. Bul. 67.

^e Massachusetts Sta. Rpt. 1900, pp. 33, 50.

^f Pennsylvania Sta. Rpt. 1901, p. 238.

^g Illinois Sta. Bul. 58.

^h Florida Sta. Bul. 55.

ⁱ Florida Sta. Bul. 60.

H. Snyder and J. A. Hummel^a in experiments with steers studied the digestibility of alfalfa hay, alone and fed with corn meal with and without a stock feed, and green alfalfa fed alone and with barley and mangels. In the authors' opinion these trials indicate that in digestibility alfalfa hay is equal to red-clover hay. It was more digestible when fed with the grain than when fed alone.

The Utah Station^b made artificial digestion experiments with the whole plant, leaves, stalk, and flower of the Golden Vine field pea, and discussed the feeding value of the different parts of the plant and of the whole plant as compared with other feeding stuffs.

The digestibility and feeding value of rice bran was studied at the Louisiana Station by C. A. Browne, jr.^c

J. B. Lindsey^d studied with sheep the digestibility of pentosans and other constituents of the carbohydrate group in feeding stuffs, the conclusion being reached that pentosans were as digestible as "any of the other fodder groups (except in the presence of excessive incrusting substance), and the digested material is practically utilized in the animal organism to the same degree as the other carbohydrates."

The digestibility of a number of edible oils, including cotton-seed oil, was studied by J. F. Moore^e with mice and guinea pigs.

METABOLISM EXPERIMENTS.

In connection with digestion experiments the income and outgo of nitrogen is frequently determined. This was done in W. W. Cook's study of the maintenance ration of sheep and in H. Snyder and J. A. Hummel's study of the digestibility of hog millet.

One of the most important of recent contributions to the theoretical discussions of metabolism, especially the metabolism of energy, is H. P. Armsby's^f recent volume, entitled "Principles of Animal Nutrition," which summarizes, in systematic form, the available information which has accumulated in recent years regarding the principles of animal nutrition, especially from the standpoint of energy.

A respiration calorimeter of the Atwater-Rosa type, suitable for experiments with steers, has been constructed at the Pennsylvania Experiment Station by H. P. Armsby and J. A. Fries,^g cooperating with the Bureau of Animal Industry of this Department. (See also p. 519.) After the accuracy of the apparatus had been demonstrated by tests in which alcohol was burned in the respiration chamber,

^a Minnesota Sta. Bul. 80.

^b Utah Sta. Bul. 69.

^c Louisiana Planter, 30 (1903), p. 383.

^d Massachusetts Sta. Rpt. 1902, p. 69.

^e Arkansas Sta. Bul. 78.

^f Principles of Animal Nutrition, by H. P. Armsby, New York, 1903.

^g Pennsylvania Sta. Rpt. 1902, p. 280.

experiments were carried on with a steer to study the available energy of timothy hay.^a On the basis of theoretical considerations the authors came to the conclusion that for cattle a maintenance ration is a question of tissue replacement rather than of heat production, and, therefore, that the value of a given feeding stuff for maintenance depends upon the availability of its energy. For instance, it is at least very probable that the work of digestion and assimilation in the case of a material like corn meal would be materially less than in the case of hay; or, in other words, that a larger percentage of the energy of the grain would be available for the maintenance of tissue. It would follow from this that in case of a ration consisting largely of grain, a less amount of material or of metabolizable energy would be required for maintenance than in the case of a ration consisting exclusively of coarse fodder. In other words, the maintenance ration is a variable rather than a constant, depending upon the kind of food used. In the experiments reported the maintenance requirement of the steer, as computed, was 10,710 calories, the average weight of the animal during the experiment being approximately 410 kilograms. On the assumption that the maintenance requirement is proportional to the two-thirds power of the live weight, this equals 12,197 calories per 500 kilograms live weight.

An important feature of the experiments is the information they afford regarding the substituting value of nutrients. This and other theoretical questions connected with the metabolism of matter and energy are discussed at length.

^a U. S. Dept. Agr., Bureau of Animal Industry Bul. 51.

EXPERIMENT STATION WORK WITH APPLES.

By C. B. SMITH,

Horticultural Editor, Office of Experiment Stations.

Farm problems are not solved in a day. Often they are not alike two years in succession or in two contiguous localities. But they come up with each recurring season and the experiment stations are asked to solve them. The stations, located under widely varying climatic and soil conditions, undertake their solution. From time to time bulletins and reports are published showing the results obtained. These may cover but one phase of the subject as studied at one or more stations. Other stations in other States may be called upon to study different phases of the same problem. Thus data accumulate. A single bulletin may show but little progress. If one read that alone, it might seem that the advance in agricultural knowledge was slow and fragmentary. It is not, however, by considering the individual results secured at one station in one year that the amount of work accomplished or the present status of a farm problem can be ascertained, but by study of the combined results secured at all the stations for a series of years. When all the results secured over a long period of time at all the stations are brought together, it is often surprising to find how large a number of problems have been worked out. This is especially true of all our more common field crops and orchard fruits. To illustrate this and to show just what the nature of the work is that has been done and the advance that has been attained in a particular line, it is proposed to assemble the results thus far secured at the stations with the one crop—apples.

No fruit is so largely grown in America as the apple. The number of apple trees and the yield of apples in bushels far exceeds that of all other fruits combined, including citrus fruits and grapes. It is not strange, therefore, that since the establishment of the agricultural experiment stations throughout the country more than 170 bulletins and reports should have been issued on the culture of apples. A large number of these publications report the results of experimental work to show the effects in orchards of clean cultivation, sod, cover crops, fertilizers, root pruning at transplanting, different-length root grafts, crossing, girdling, thinning, harvesting, storing, cold storage, composition, utilization, and other problems. It is work along these lines

that has been reviewed in this article. The work with varieties and in spraying, and studies of the diseases and insects affecting apples, have been omitted. So much has been done along these lines that, if properly reviewed, it would fill a volume. Attention in this article has therefore been centered on the other questions relating to apple growing which have been investigated by the stations.

PERIOD OF GROWTH.

In investigating the growth of the branches of apple trees the Wisconsin Station found^a that active branch growth ceased one year June 4, while the following year it continued on many trees until October 1. Cultivation or late rain and favorable weather may induce trees to make a second growth, commencing the middle of July or later. One instance is cited where, out of 325 trees that had made a second growth, 66 per cent were in cultivated ground and 21.1 per cent in sod. On the cultivated soil the branch growth on many trees was as much as one-half inch per day. Many apple grafts, top-worked, continued to grow several weeks later than the stocks. The bark was set on many of the smaller branches by August 15, while on the larger trunks it could still be peeled at that date. Another season the bark slipped readily on all branches up to September 15, and on the larger branches to September 25. Root growth was found active one season as late as October 6, although no growth of twigs had occurred on any of the trees later than July 1.

In Tennessee the experiment station found^b that, as a general rule, apple shoots make their principal growth in length before July 1 and that the outermost shoots finish their growth in length sooner than the lower shoots. An examination of the growth of buds on the various trees showed that 50 per cent of all the buds found on Jonathan in 1900 above the lowest limb started into growth by June 30, 1901, and 15 per cent had made shoots three-fourths inch long or more. With York Imperial 60 per cent had started into growth and 28 per cent made shoots.

APPLE BUDS AND POLLEN.

An extended study has been made by the Wisconsin Station of the development of apple buds and the germination of apple pollen. It was found that leaf buds and flower buds are not structurally distinct. Every bud on the apple tree is formed as a leaf bud and every bud on the tree has the power to become a flower bud. Leaf and flower buds are, in a measure, interchangeable. By pruning away the branch immediately above a flower bud it may be converted into a leaf bud,

^a Wisconsin Sta. Rpt. 1900, p. 3.

^b Tennessee Sta. Bul., Vol. XIV, No. 4.

and by ringing a branch just below a leaf bud it may be converted into a flower bud. Factors which tend to the formation of flower buds are any restriction of prepared food in the branches, such as is caused by ringing or a wrinkling of the bark formed by the union of the fruit spur with the branch which supports it. Dry weather is also conducive to the formation of flower buds, since during such dry periods evaporation through the leaves is rapid and sap becomes concentrated and rich in prepared food. Flower buds are then formed in portions of the tree where there may be no restrictions to the movement of the sap, as at the end of young shoots. Whenever the water supply is increased the tendency is to wood growth and the formation of leaf buds. A decrease in water supply tends to make flower buds. A normal growth is accompanied by normal formation of flowers. When the fruit spurs of a healthy tree push into growth or sap sprouts start freely from the old wood, growth is abnormal and fruit production is postponed.^a

The first clear evidence of flower buds on the apple tree was found one season June 30.^b Another season flower buds for the most part were formed between August 1 and September 3.^c Flower buds do not usually form until active wood growth for the season stops. At that time they may begin and continue until cold weather sets in. The same fruit spur has been found to fruit annually in some instances, instead of biennially, as has sometimes been claimed. In the flower buds the calyx and receptacle are first to appear, next the stamens and petals, which are apparently outgrowths of the calyx or receptacle, and finally the pistils, which are extremely slow in developing. The observations indicate that flower buds seldom or never revert to leaf buds, though they may not develop into flowers for several seasons. If heavily shaded they may never bloom; but during very favorable seasons for the formation of flowers all the 1-year old, 2-year old, and 3-year old flower buds, many older buds, and some buds formed during the year, may form embryo flowers. This explains why an excessive fruit crop is always followed by a scanty one. "There are no reserve buds. Only the buds formed the preceding season are developed, and the draft on the tree necessary to develop so many apples prevents many of these from forming flowers, even if they are of the annual flowering variety."^a

While the production of flower buds on the apple tree is largely controlled by climatic conditions, a number of other factors also enter in over which the orchardist has control. The temperature may be modified by planting on the north or northeastern slopes. Early

^a Amer. Gard., 22 (1901), No. 332, p. 330.

^b Wisconsin Sta. Rpt. 1899, p. 289.

^c Wisconsin Sta. Rpt. 1901, p. 304.

spring plowing and frequent shallow cultivation will preserve a good supply of moisture in the soil, which is so essential to the growth of healthy leaves and buds. In seasons of excessive rainfall the ground may be left uncultivated to hasten evaporation. In the Northern States it is desirable for the formation of flower buds that wood growth come to an end about July 1. Should growth continue after this date it may be checked by moderate root pruning. This can be accomplished by plowing a furrow down the rows each way, followed by a subsoiler, so that the small roots on each tree can be cut off. Plowing should be followed by a cover crop to evaporate any excess moisture in the soil.

At the Rhode Island Station^a a study was made of the effect of light on bud development. An examination was made of the number of flower buds on limbs exposed to sunlight as compared with those on limbs partially shaded. The proportion found was 182 clusters on limbs in sunlight and only 136 on limbs partially shaded. This suggests the desirability of thinning out the tops of trees that become too luxuriant in wood and leaf growth, so that more flower buds may be produced.

The Canada Experimental Farms^b report some experiments in which whitewash covering the trees appeared to have but little effect in retarding the swelling of apple buds in the spring. Mulching apples with strawy manure in winter when the ground was deeply frozen and covered with 8 to 12 inches of snow did not retard leafing and blossoming the following spring.

Some of the conditions controlling the germination of apple pollen have been studied and reported upon by the Wisconsin Station.^c In a saturated atmosphere under a bell jar apple anthers failed to burst after fifty-six hours, while in dry air the anthers on duplicate twigs had practically all burst. The experiment is believed to indicate that during periods of protracted rain, or as long as the trees are wet with rain or dew or enveloped in fog, practically no anthers burst and therefore no pollen is wasted. The anthers were not found to swell perceptibly until the maximum temperature reached 70° F. Other laboratory experiments with blossoms indicate that pollen is discharged freely only in warm and dry weather. At a temperature of 40° to 51° F. pollen germination was very feeble, a fact which indicates that the vitality of the pollen is not likely to be injured by exposure to a prolonged rainy period if the weather remains cool. If it rises to 65° or 70° F. the vitality of the pollen may be destroyed.

Observations at the New Jersey stations^d showed that no apples set when the fruit blossoms were not permitted to get dry during the period of pollination.

^a Rhode Island Sta. Bul. 37.

^c Wisconsin Sta. Rpt. 1901, p. 289.

^b Canada Expt. Farms Rpts. 1899, p. 94.

^d New Jersey Stas. Rpt. 1899, p. 221.

Laboratory investigations at the New York State Station^a showed that any of the ordinary insecticides or fungicides prevent the germination of pollen on the stigmatic surface of the pistil if applied before the pollen reaches the pistil. In the orchard spraying mixtures largely prevented the pollination of the freshly opened blossoms and the setting of fruit. In some cases the spraying mixtures had a decisive corrosive effect on the tissues of the stamens and pistils. Blossoms which had been open several days before spraying were not seriously injured by spraying mixtures, the fruit setting in abundance. The yield of a number of varieties from spraying in bloom was slightly diminished, but the total marketable fruit was in nowise diminished. On the whole, there was no apparent injury as regards the resulting fruit crop in spraying orchards in full bloom. Fletcher^b has shown that under normal conditions only about one blossom in ten sets fruit, even in the most favorable season and with the most productive varieties, so that many of the blossoms that open might be killed by spraying or otherwise and still a full crop of fruit be secured.

SELF-STERILITY IN APPLES.

According to S. W. Fletcher,^c orchard fruits can not be separated into self-sterile and self-fertile varieties, since self-sterility is not a constant character. Some varieties which are self-sterile under one condition may be self-fertile under another. A number of the stations have made observations on the self-sterility or self-fertility of apples. Work at the Delaware Station^c during two seasons indicates that practically all the more important varieties grown on the Chesapeake peninsula are probably self-sterile. July and Bough, both of little commercial importance, were the only varieties that set any considerable amount of fruit when self-pollinated. Astrakhan, Early Harvest, and Yellow Transparent were more or less self-fertile and, under favorable conditions, might produce crops. The varieties that were found self-sterile, or nearly so, were Early Ripe, English Russet, Fanny, Gilpin, Gravenstein, Grimes, Lily of Kent, Missouri Pippin, Nero, Paragon, Red Streak, Stark, Stamen, Strawberry, William Favorite, and Wine-sap. The self-fertile kinds were confined almost exclusively to summer sorts. Gilpin, a winter sort, set a few fruits, but they dropped as the season advanced.

At the Vermont Station^d the following varieties were found to be self-sterile: Rhode Island Greening, Ben Davis, Hawley, King, Northern, Northern Spy, Porter, Red Astrakhan, Red Kennedy, Roseau, Roxbury Russet, Tolman Sweet, Wealthy, Westfield (Seek-no-further), and William Favorite. The varieties Baldwin, Esopus, and Famense were

^a New York State Sta. Bul. 196.

^c Delaware Sta. Rpt. 1901, p. 83.

^b New York Cornell Sta. Bul. 181.

^d Vermont Sta. Rpt. 1900, p. 362.

slightly self-fertile. One Baldwin fruit set out of 150 blossoms covered, 1 Esopus out of 86 blossoms covered, and 1 Fameuse out of 223 blossoms covered.

At the Kansas Station,^a Grimes Golden, Arkansas Black, and Mammoth Black Twig failed to set a single fruit without cross-fertilization, and Huntsman was practically self-sterile. The variety Ben Davis, which was found self-sterile in Vermont and also in Canada, proved self-fertile at the Kansas Station. Twenty-six out of 100 blossoms of this variety covered set fruit. The self-pollinated fruit, however, was not so large or so vigorous as that from cross-fertilized blossoms. There was also a greater tendency of the self-pollinated fruits to fall from the tree before they attained the size of a hazelnut. They responded readily, however, to the pollen of almost any other variety. Jonathan, Huntsman, and Cooper Early proved especially valuable as pollenizers in orchards. The varieties Cooper Early, Jonathan, Smith Cider, Smokehouse, White Pearmain, and Wine were all more or less self-fertile.

Experiments in intercrossing varieties of apples at the Delaware Station^b indicate that Paragon, Stamen, Winesap, and Lily of Kent—all weak pollen bearers except the latter—are intersterile and should not be planted together in commercial orchards for the purpose of cross-pollination. Fletcher^c found the varieties Bellflower, Primate Spitzenburg, Willow Twig, and Winesap to tend toward self-sterility. The varieties Stark, Longfield, and Tolman Sweet were self-fertile, but much larger fruits of Stark and Longfield were obtained when they were cross-fertilized. There appeared to be no increase in size from cross-fertilizing Tolman Sweet.

In Canada H. S. Peart^d reports that the varieties Alexander, Baldwin, Chenango, Early Harvest, Greening, Holland, Twenty Ounce, and Ontario showed a certain amount of self-fertility when the blossoms were covered with paper bags. Twenty-one other varieties were found self-sterile. The eight varieties which are mentioned specifically as being self-sterile are Blenheim, Ben Davis, Canada Red, King, Mann, Fameuse, Spy, and Ribston. The Spy was found to bloom at the same period as Ben Davis and Princess Louise.

The data secured at the above stations show that a very large number of varieties of apples are self-sterile. Further experiment with other varieties is likely to increase the list of self-sterile sorts. The practical conclusion that can be drawn from this work is that large blocks of apples of a single variety should never be planted. Two or more varieties should be mixed in alternating rows. Varieties standing next to each other should be such as will blossom at the same time and be capable of cross-fertilizing each other.

^a Industrialist, 29 (1902), No. 11, p. 163.

^c New York Cornell Sta. Bul. 181.

^b Delaware Sta. Rpt. 1901, p. 83.

^d Canad. Hort., 26 (1903), No. 9, p. 361.

In a study of the blooming period of varieties of apples at the Delaware Station it was found that good tillage, spraying, fertilizing, etc., extended the period of flower-bud formation in the fall and seemed to prolong the blossoming period in the spring, while on poor, uncultivated soils the blooming period was shortened.

In studying the agents of pollination in Kansas, Greene^a found that honeybees were most useful. He found that bees worked for the most part on the side of the tree away from the wind. With an east wind 20 bees were counted on the west side of a Huntsman tree in full bloom and but eight on the east side. These figures were duplicated with other varieties. Bees were noticed to visit the same flower five or six times within the course of twenty-five or thirty minutes. While the honeybee was found the greatest agent in pollination, enough other bees were present to insure a crop of fruit when the weather was favorable. Microscopic slides carefully prepared with adhesive material and placed at different distances from trees in full bloom in such a manner as to catch any pollen that might be carried by the wind indicate that the wind does aid in pollination, though not to any great extent in the case of apples.

CROSSING.

Experiments in cross-breeding Russian varieties of apples at the Iowa Station^b would seem to indicate that "hardiness follows largely the mother variety and that the fruit is most frequently modified by the male parent." The Canadian experiment stations have reported the results of extensive work in cross-breeding hardy varieties of apples and crabs for planting in the uncongenial regions of the Northwest. Of 200 of the hardiest varieties of apples and crabs planted at Brandon and Indian Head, none produced fruits except seedlings of *Pyrus baccata*. The blossoms of this apple have been cross-fertilized with pollen from such hardy improved sorts as Tetofsky, Wealthy, and Duchess, and also with pollen of Transcendent, Hyslop, and Orange crabs. A number of trees from these crosses have fruited and the fruits have proved a great advance on the original crab. Sixteen or seventeen varieties have been named and a number distributed throughout different sections of the Northwest. While the apples secured are small, they make very good apple sauce and jelly and promise to be of great usefulness to people in those cold regions.

ROOT GRAFTING.

Several of the experiment stations have made experiments in using different lengths of roots and scions in grafting. The most extensive

^a Industrialist, 29 (1902), No. 11.

^b Iowa Sta. Buls. 14 and 32.

work along this line has been reported by the Kansas Station.^a The experiments extended over a number of years and included tests of the value of 24, 12, and 6-inch scions grafted above and below the crown, and of the use of whole roots and of different-length piece roots. The longest scion uniformly produced the best trees, but it is not believed that the increased growth is sufficient to pay for the expense and trouble of making 24-inch scions, and it is believed doubtful if it would pay for 12-inch scions. The growth on whole roots was somewhat greater during the two years than on piece roots. The third year, however, this difference largely disappeared. An examination of an orchard set with trees grown on whole roots, piece roots, and budded stock showed that the trees had made fully as good or better growth on the piece root and budded stock ten years after planting as on the whole-root stock. The work of the station leads to the conclusion that the manner of propagation counts for little after growth commences. Whole-root grafted apple trees are of no greater value to the buyer than trees grafted on piece roots of 5, 4, or 2½ inches in length. There was no constant difference in grafting an inch above the crown or an inch below it when the trees were set 3 or 4 inches deep in the soil. In these experiments the principal root growth was made at or just below the union of the stock and scion.

In experiments at the Illinois Station^b no better results were obtained with whole roots than with piece roots of the same size. Roots with the small side branches left on gave better results than roots of the same size with the rootlets cut away. Roots 5 inches long gave better results than roots 4 inches, 2 inches, or 1 inch long. When not trimmed, roots 5 inches long gave nearly as good results as roots 10 inches long. At the Alabama Station^c 1-year-old trees which had been grafted on the bottom half of roots made a better growth than trees which had been grafted on the upper half of roots or on whole roots, and it is believed from the results obtained that the superior advantages claimed for whole roots are without foundation. In an experiment with Summer Wafer apples at the Oregon Station^d grafting on whole roots appeared to give slightly better results than grafting on either the lower half or upper half of the root.

When the work at all of the different experiment stations in root grafting is carefully reviewed, the conclusion seems inevitable that, for all practical purposes, grafting the apple on pieces of roots 2½ to 5 inches long is likely to prove most profitable to the grower and equally satisfactory to the planter.

^a Kansas Sta. Buls. 65 and 106.

^b Illinois Sta. Bul. 21.

^c Alabama College Sta. Bul. 98.

^d Oregon Sta. Rpt. 1901, p. 36.

PLANTING AND PRUNING TREES.

A comparison was made at the Nebraska Station^a of the growth in the orchard of 1-year whips, 2-year whips, 2-year tops on 3-year roots, and 2-year limb trees. At the end of three years there was a slight advantage in growth in favor of the 3-year-old trees. The 2-year limb trees stood second. The 1-year trees were smallest, but had made a much larger growth relatively than the older trees. The results are believed to indicate that it is better to plant 1-year trees, if available, rather than wait another year in order to get older trees. Cutting back apple trees after planting to a mere whip is not believed to be good practice. While such trees are as likely to live, they lose in growth. Shortening the branch back about half seemed to give better results than not heading it at all and was much better than pruning to a whip. In a similar series of experiments at the Rhode Island Station,^b covering a period of three years, Professor Card came to the conclusion that, for practical purposes, the most rational method of transplanting trees in the orchard is to leave on all sound roots and shorten back the tops about half. Other experiments at the Nebraska Station indicate that fall-planted trees do make some root growth late in the fall and early in the spring before leaf growth starts. Notwithstanding this fact, however, it is believed that fall planting will not prove as satisfactory in that State as spring planting, because of the drying effects on the trees over winter.

In Wyoming^c a test was made of eastern versus western grown trees. At the end of the year 38 per cent of the trees obtained from New York had died, while only 9 per cent of those obtained from Colorado had died. In another experiment the figures were 32½ per cent and 17 per cent, respectively, in favor of western trees.

In experiments reported by the Woburn Experiment Fruit Farm in England,^d where trees were not cut back at planting nor subsequently pruned, they were straggling in form and there was a general loss in vigor of growth. Nevertheless, the amount of fruit borne by such trees was in excess of the average. When the trees were cut back at planting and not subsequently pruned they assumed the general straggling form noted above, but suffered no loss in vigor of growth. The experiments were slightly in favor of an immediate cutting back on setting rather than waiting until a year later. Trees root-pruned every year for four years after planting out made but little more than half the growth of normal trees, and those root-pruned every other

^aNebraska Sta. Bul. 56.

^bRhode Island Sta. Rpt. 1901, p. 238.

^cWyoming Sta. Bul. 34.

^dWoburn Expt. Fruit Farm Rpt. 1900, pp. 106, 252.

year only about two-thirds as great a growth. The crops borne by these trees, however, were heavy in proportion to their size.

Some experiments in pruning trees every two months during the year at the Nebraska Station^a seemed to indicate the growing season as most preferable, since the wound healed better than when made in the winter. As to making the wounds smooth or rough, but very little difference could be noticed, what difference there was being in favor of leaving them rough. Untreated wounds seemed to heal as well as those covered with wax, paint, or like material, but checked worst of all. Lead paint was as satisfactory a material for covering the wounds as anything tried, followed closely by grafting wax. Coal tar seemed to prevent healing. Shellac was a failure; it neither aided in healing nor prevented checking. Pine tar had nothing to recommend it.

Prof. E. S. Goff^b has pointed out that as apple trees increase in age the size of the fruit tends to become smaller. This is believed to be due to the increased difficulty of sap circulation in the fruit-bearing tree. He cites an instance in which water sprouts on part of an apple tree were allowed to develop in place of a large limb that had been broken off. The fruit on this portion of the tree was much larger than on the remaining old portions of the tree. The question is therefore raised whether the size of fruit on old apple or pear trees can not be maintained by a careful system of renewal pruning.

Some data are given by the West Virginia Station^c to show the effect of top grafting and root grafting on the longevity of some varieties of apples. Trees of the King apple, twenty years old, top-worked on seedlings were in fairly good condition, while others of the same variety root-grafted and set in the same orchard at the same time had been dead for ten years. Ten top-grafted and ten root-grafted Walldow apple trees were set in an orchard at the same time. The top-worked trees at the age of twenty years were alive and thrifty, while of the root-grafted trees only one limb of one tree was living, the majority of the trees having died between the ages of five and ten years. In an apple orchard planted with 100 root-grafted and 70 top-grafted trees, 44 per cent of the former and only 7.2 per cent of the latter had died.

In propagating varieties of apples that have weak trunks top grafting, or even better, double working is recommended. For double working Tolman Sweet is considered a good variety, since it possesses close, smooth bark, a strong yet not rapid growth, and a great length of life. In this connection G. T. Powell reports that he has successfully grown the King apple in New York by using the Northern Spy

^a Nebraska Sta. Bul. 50.

^b Amer. Gard., 23 (1902), No. 385, p. 302.

^c West Virginia Sta. Bul. 47.

as a foundation stock. In this work choice buds taken from trees that regularly produced an excellent quality of fruit were used. No canker has appeared on these trees during the past ten years. The trees have shown unusual thrift and vigor and the fruit has been uniformly fine. The Delaware Station^a also considers the Spy an ideal stock to top work.

ROOT PRUNING APPLE TREES.

About 1890 H. M. Stringfellow, of Texas, wrote a series of articles on fruit growing, in which he urged the advantage and desirability of cutting off all roots of nursery trees at transplanting time to mere stubs and cutting back the stem to about a foot. So many were the advantages claimed for this method and so strenuously were they presented that a number of stations took up the matter and made careful experiments with different orchard fruits to see what there was in it. Only the results secured with apples will be considered here.

At the Georgia Station^b apple trees were pruned to mere knobs and planted in dibble holes on a red loam with a stiff red-clay subsoil, in comparison with trees with whole roots planted in the usual manner in standard holes. The root-pruned trees made fewer, deeper, larger, and more robust roots than the other trees, the depth of penetration for typical roots being $17\frac{1}{2}$ inches against $9\frac{1}{2}$ inches for the unpruned trees. From this experiment with apple and other fruits it is concluded that stub-pruned apple trees will live and flourish under Georgia conditions.

In some experiments reported by the Oregon Station^c every alternate tree in a row containing 24 trees was pruned by the Stringfellow system, while the others were root-pruned and the tops cut back 30 inches. At the end of two years it was practically impossible to tell by the eye alone which tree had been pruned according to the Stringfellow method and which had not. Two trees set out at the same time, without either top or root pruning, presented a very unthrifty appearance in comparison with the pruned trees.

In one test at the Montana Station^d 60 per cent of stub root-pruned trees lived over winter, while 70 per cent of those not root pruned lived. In another experiment at the station^e 89 trees of Wealthy and Alexander were stub pruned, stem cut back 12 inches, and the club thus left set with a crowbar. By July the same year 18 per cent of the trees were dead, 56 per cent in good condition, and the rest weak. The fact that 75 per cent of the dead trees were of the Alexander variety is taken as indicating marked difference in the ability of the different varieties to withstand this treatment.

^a Delaware Sta. Bul. 48.

^b Georgia Sta. Bul. 40.

^c Oregon Sta. Rpt. 1901, p. 36.

^d Montana Sta. Bul. 24.

^e Montana Sta. Bul. 28.

At the Nebraska Station^a Professor Card planted 25 apple trees root pruned according to the Stringfellow method, 25 with roots cut back one-half, and 25 with the roots wholly untrimmed, just as received from the nursery. The Stringfellow pruned trees started into growth much slower than the others and made a much poorer root development. Nine of the trees died during the season and the remainder made a very poor growth, while none of the trees with the roots shortened half or left without pruning died. A few of the Stringfellow pruned trees made a very excellent root growth, but generally proved much inferior to the other methods of treatment. These results are believed to show that, under the conditions prevalent in Nebraska, apples may be able to overcome the effects of pruning to stubs, but at best they will be retarded a year or two, while many will succumb altogether. An examination of the root growth of the different trees showed that the roots started from the tops or sides of other roots just as readily as from the root ends, and apparently there was little to indicate that those which started from the trunk ran deeper than the others. More roots started from the trunk with the ordinary methods of pruning as a rule than with the Stringfellow method. For Nebraska conditions the experiment is believed to show that for best results all the roots which are found on the tree as shipped from the nursery, excepting those bruised or otherwise mutilated, should be left there in planting. It was observed in these experiments that callousing did not progress well and new roots did not start readily from the ends of roots crushed or bruised.

When Professor Card repeated these experiments at the Rhode Island Station^b on moist soil every one of the stub-pruned trees lived and made a good growth. After three years' observation he states that these trees will make well-formed trees with heads just at the ground. Generally a large number of branches start out from the trunk, which in turn branch at about 2½ feet from the starting point.

Professor Powell^c made a careful study of the Stringfellow method of stub pruning at the Delaware Station. He used three lots of 18 trees each. One lot was pruned to stubs according to the Stringfellow method, another to 3 inches, and the third to 8 inches. Thus prepared the trees were planted on heavy clay land. Duplicate lots were also planted on light, sandy loam. At the end of three years all of the trees of each lot planted on the heavy clay land were alive; but while all of the 8-inch and 3-inch root-pruned trees developed into first-class trees, but 12 of the stub-pruned trees, or 66⅔ per cent, were first class. On the light, sandy loam soil 17 of the trees root pruned to 8 inches made first-class trees, 16 of those pruned to 3 inches, and 12 of those

^a Nebraska Sta. Bul. 56.

^c Delaware Sta. Bul. 45.

^b Rhode Island Sta. Rpt. 1901, p. 238.

stub pruned. In another test 10 two-year-old stub-pruned apple trees were planted in comparison with 10 trees root pruned to 3 inches. All the trees pruned to 3 inches lived; one of the stub-pruned trees died. The following spring half of the trees of each lot were dug and examined. Two out of five of the 3-inch root-pruned trees were first class, while none of the stub-pruned trees were first class.

In these experiments the root systems formed on the differently pruned trees were carefully studied. The new roots were found to arise most easily from the ends of the smallest roots and from those portions of large roots nearest the growing tips. The fibrous roots, when uninjured, were first to throw out new absorbing feeders. The direction of growth of the root system was not found to be more downward on the stub-pruned trees than on those pruned to 3 and 8 inches, respectively, either on sandy loam or heavy clay. Nor were there any more tap roots formed on the stub-pruned trees than on those pruned longer.

The general conclusion is drawn from these experiments that Delaware growers should prune the roots of fruit trees to a length of 3 to 5 inches at transplanting. "Shorter roots present no emphatic advantages and longer roots are useless and expensive to set in the ground."

In a bulletin from the Washington Station^a it is stated that at that station the Stringfellow system of root pruning has not indicated any advantage for the method. R. Goethe^b reports some German experiments in which some 15 apple trees were root pruned according to the usual method and 15 stub pruned according to the Stringfellow method. Fourteen of the trees in the first lot grew well and made a good root system, while of the 15 pruned according to the Stringfellow method 12 died outright. In a test of the Stringfellow method of planting on the Rural New Yorker trial grounds,^c out of 132 apple trees planted and given no attention other than a manure mulch, 37 have died. The others have made a one-eighth to one-fourth normal growth on the average. Check trees planted with whole roots showed 75 per cent of a normal growth. A writer in New Jersey^d states that he set out 1,000 trees root pruned according to the Stringfellow method, and that at the end of the first season 800 of them were dead and the remainder had made a very poor growth.

A careful review of all the available data, experiment station and otherwise, on the subject shows that in some localities the Stringfellow method of pruning apple trees at transplanting time gives entirely satisfactory results, and trees thus treated make as good a growth as when treated by the usual methods. The Georgia, Oregon, and Rhode

^aWashington Sta. Bul. 52.

^bBer. K. Lehmanst. Wein, Obst- u. Gartenbau, Geisenheim, 1900-1901, p. 18.

^cRural New Yorker, 61 (1902), No. 2745, p. 606.

^dRural New Yorker, 62 (1903), No. 2799, p. 661.

Island stations have reported experiments of this character. On the other hand, in Nebraska, Delaware, Washington, New Jersey, and New York the usual method of planting has been more satisfactory, stub-root pruning proving less valuable and often decidedly injurious. Climate seems to effect the success of the stub-pruned method of handling trees more than soil, since in the experiments cited above the stub-pruned trees made a good growth on a red loam with a stiff red-clay subsoil at the Georgia Station, and as good a growth on heavy clay land in Delaware as on lighter sand. In the dry climate of Nebraska stub pruning was practically a failure, while more or less success followed its observance in the more moist Atlantic and Gulf coast States.

The results of Professor Card's experiments in both Nebraska and Rhode Island led him to recommend planting trees with all the roots left on except those that have been mutilated. Professor Powell, on the other hand, recommends fruit growers in Delaware to plant trees with the roots trimmed back to a length of 3 to 5 inches. The experience of station horticulturists is quite concordant in showing that the root system developed by stub-pruned apple trees is not more downward, as claimed by Mr. Stringfellow, than is the root system formed by trees planted the ordinary way. Nor does cutting back the trunk of the apple tree to a mere stick 12 inches long conduce to the formation of as desirable a trunk as by pruning in the usual way. In short, the chief advantage which the Stringfellow method of stub pruning seems to possess over other methods in localities where it will succeed at all is the greater convenience in handling and greater ease in setting out stub-pruned trees. The safest method for most northern and western localities is the old method whereby the limbs are pruned back about half and all the roots left on or slightly shortened, all the mutilated roots being removed.

HARDY STOCKS.

In South Dakota^a Russian seedlings of *Pyrus baccata* have proved the only varieties perfectly resistant against root killing in severe winters. In a report by the Wisconsin Station,^b covering the whole region of Wisconsin, Minnesota, Iowa, the Dakotas, and Manitoba, it is stated that crabs were less injured than common apples during the February freeze of 1899, when the temperature in some localities fell as low as -52° F., and this fact suggests the advisability of using crab roots for stock in the Northwest. Nursery apple stock least injured by the freeze was Duchess of Oldenburg, Hibernial, Wealthy, and Whitney No. 20, in the order named. In the orchard 23 correspondents reported Wealthy least injured, 21 Duchess of Oldenburg, 9

^aSouth Dakota Sta. Bul. 65.

^bWisconsin Sta. Bul. 77

Yellow Transparent, and 6 Hibernial. It is thought by the station that, had the crab been generally used for root grafting the apple in the Northwest, the loss from root killing would have been reduced at least one-half.

Based on the assumption that the roots of trees are as hardy as the tops, it is a frequent practice to plant trees quite deep in order not only to protect the roots, but also to encourage the scion to send out roots. This is especially desirable when tender stocks are used. Professor Hansen, however, states^a that these roots are not hardy against test winters, and in South Dakota no roots from the scions should be permitted. Only *Pyrus baccata* stock is perfectly hardy. As an aid to the protection of nursery stock he strongly advises watering trees in the fall before the ground freezes and then applying a heavy mulch.

CULTIVATION AND COVER CROPS.

Of late years the practice has been growing among farmers of giving orchards clean cultivation from early spring until midsummer, and then seeding down to some crop that will make a fair growth in the fall and keep the ground protected over winter. The purpose of stopping cultivation in midsummer and of putting on the soil a growing crop is to dry out the soil by evaporation of moisture through the growing plants and thus to ripen up the wood growth of the tree before winter comes on. In addition to this, the cover crop when turned under enriches the soil in humus and also in nitrogen, should it be a leguminous crop. It also prevents the soil from freezing as deeply in winter and keeps it from winter washing.

That cultivation during part of the season at least rather than cropping of orchards is a correct practice is demonstrated by actual trials at a number of experiment stations. Measurements of the normal growth of about 600 trees through several seasons by Prof. J. C. Whitten at the Missouri Station^b showed the average growth of miscellaneous varieties of apple trees given clean cultivation until midsummer, then seeded to a cover crop, to be 13.6 inches, while trees in blue-grass pasture made an average growth during the same period of but 6.2 inches, or less than half the growth of the cultivated trees. In the same experiment trees of the Genet variety in clover without cultivation made an average growth of 10.2 inches per year for 4 years. Trees of Ben Davis given clean cultivation throughout each growing season made an average growth of 21.75 inches per season, while other trees of the same variety in clover grew but 13.4 inches. It was observed in these experiments that the cultivated trees made a more uniform growth than the uncultivated trees and were less affected

^aSouth Dakota Sta. Bul. 65.

^bMissouri Sta. Bul. 49.

by droughts. Relative to the latter point, the observations brought out clearly that the effects of droughts on cultivated trees are more apparent the succeeding season than during the dry year itself. Professor Whitten's observations and measurements indicate that "a marked falling off in height, growth, and a generally devitalized condition of the trees may be looked for in uncultivated orchards for a year or two following an excessive autumn drought." He holds that in a dry summer cultivation should be continued until the crop of fruit is mature or rain comes. In a wet summer and autumn, cultivation should cease in that State about August 1.

The actual length of time to continue cultivation in the orchard will, of course, vary with different conditions. In North Dakota, for instance, where the winters are colder, the growing season shorter, and the rainfall less than in eastern United States, Professor Waldron states^b that cultivation should be continued much later in the season to preserve all the moisture in the soil possible, since in soils lacking in moisture the trees winterkill. Mulching the trees in late fall to maintain moisture during the winter in that State has been found of the greatest importance.

The reason why severe freezing injures apple roots and trees more in dry soils than in moist ones has not been definitely settled. Professor Emerson^c suggests, as the result of experiments along this line, that it may be on account of the more pronounced freezing and thawing in such soils. Professor Bailey,^d on the other hand, points out that there is evaporation of moisture from trees during the winter season and, if the ground is very dry, this loss can not be readily met and the trees thereby "freeze dry," a condition generally fatal.

The amount of moisture in clean, cultivated orchard soils as compared with the moisture content of the soil of orchards in grass is contrasted in the table herewith:

Moisture content of soils in cultivated and uncultivated orchards.

Place of experiment.	Depth of soil examined.	Clean cultivation.	Orchard in grass.	Cultivated crops.
	Inches.	Per cent.	Per cent.	Per cent.
Kansas ^a	15	16.0	6.0	8 to 11.0
Nebraska ^b	20	20.4	14.0	.....
Nebraska ^c.....	.....	22.0	.....	16.5
Illinois ^d	27	12.0	8.0	12.0
Iowa ^e (in winter).....	6	31.4	21.8	.....
New York ^f.....	.....	12.0	9.0	.....

^a Kansas Sta. Bul. 106.

^d Illinois Sta. Bul. 52.

^f New York Cornell Sta. Bul. 72.

^b Nebraska Sta. Bul. 39.

^e New York Cornell Sta. Bul. 198.

^g Untilled.

^c Nebraska Sta. Bul. 79.

A study of the data in the table shows that in dry seasons clean cultivation has a remarkable effect in conserving soil moisture. An

^a Missouri Sta. Bul. 49.

^c Nebraska Sta. Bul. 79.

^b North Dakota Sta. Bul. 49.

^d New York Cornell Sta. Bul. 117.

examination of the last column of the table shows that the effect of cultivated crops like corn and vegetables is less drying on the soil than grass or small grain crops. Not only is there more moisture in tilled soils than in untilled, but it is distributed nearer the surface, where it is likely to be most effective and readily available for the use of the trees. In orchard tillage experiments at Cornell^a Professor Bailey found that in tilled soils the moisture was well distributed to within 2 inches of the surface, while in uncultivated soils the first few inches were exceedingly dry.

At the Illinois Station^b orchard trees given clean cultivation made the healthiest and most vigorous growth of several different methods of management tried. Next in order stood the orchards planted in corn, and following this orchards planted in clover, oats, and blue grass, respectively. Trees in blue grass made trunks only about half as large during the same number of years as trees given clean cultivation.

In some English experiments^c trees grown in grass were but little larger after five years than when set out, and were only one-eighteenth as long as trees given clean cultivation. In these experiments weeds were much less serious in their effects upon tree growth than grass. At the Utah Station^d an experiment was made in seeding different parts of a young orchard with alfalfa, clover, timothy, and a mixture of timothy and clover, respectively. At the end of three years the majority of the trees thus treated were dead, while where clean cultivation had been given, practically every tree was alive and doing well.

Professor Emerson, of the Nebraska Station,^e found that clean cultivation dried the soil least of several different methods of cultivation tried, while vegetables dried the soil but little more than clean cultivation. Corn stood next, followed by oats and rye. In a dry season there was two to three times as much moisture available to the trees in clean cultivated plats as in an oat plat. Rye dried the soil most of all. This crop comes on early in the season and, on account of its rapid growth, uses up the soil moisture very rapidly, and it is in the early part of the season during the period of most active wood growth that drought produces most serious results. The orchard experimented upon by Professor Emerson had only recently been set out. Where oats were sown in the orchard more than 50 per cent of the trees died, while less than 3 per cent died on the plat given clean cultivation, less than 7 per cent where vegetables were grown, and less than 9 per cent

^aNew York Cornell Sta. Bul. 72.

^bIllinois Sta. Bul. 52.

^cWoburn Expt. Fruit Farm Rpt. 1900, pp. 106, 252.

^dUtah Sta. Bul. 37.

^eNebraska Sta. Bul. 79.

where corn was grown. Professor Card, at the same station,^a obtained 14 to 17 per cent more fruit in tilled orchards than in orchards in grass.

Mulching orchards is sometimes advocated in place of tillage. Munson at the Maine Station^b conducted experiments for four seasons along this line, and found that in general the trees on the cultivated areas made the larger growth and produced the heavier yield of fruit.

Generally speaking, the results of experimental work thus far reported indicate that the most serious injuries to orchards occur when planted to crops like grasses and the cereal grains, which dissipate the soil moisture early in the growing season. Cultivated vegetables are distinctly less injurious. When orchards are in full bearing it is quite generally agreed that no crop for profit should be grown in them. In the young orchard cultivated crops like vegetables, small fruits, or corn may be grown between the rows for a few years, the crops being more and more restricted to the middle of the rows as the trees become larger and begin to bear fruit. In no case should crops be planted so close to trees as to interfere with the cultivation of the trees or to shade them.

The above review shows that most of the tillage work with apples has been along one line—that of the value of tillage in conserving the moisture of the soil and increasing the growth of the tree. There are scarcely any data on the value of orchard tillage in increasing the yield of fruit. Some figures showing the actual results along this line would be extremely useful. The chief purpose of tillage, that of supplying food to the plant, must not be lost sight of in this limited discussion; nor must it be forgotten that sometimes the growing of crops in orchards is very desirable, as for instance when orchards are planted on steep hillsides that would wash unless cropped. The fact, too, that growing crops rapidly evaporate the moisture of the soil is sometimes taken advantage of when orchards are planted on poorly drained land. In localities also where danger from drought is not to be feared orchards may be very successfully left in grass or clover, provided these crops are cut and left on the ground to decay or fed to stock and the manure returned to the orchard.

Station observations on growing cover crops in orchards have generally been limited to a study of the relative amount of green material produced by different farm crops used for covers, their fertilizing value, best methods of seeding, etc. Professor Taft considers the lessening of the injury from frost one of the most vitally important results to be secured with orchard cover crops. This fact is well brought out in the experience of nurserymen and orchardists in the North Mississippi Valley during the test winter of 1899, when the thermometer in some portions of the section, including Wisconsin, Min-

^a Nebraska Sta. Bul. 39.

^b Maine Sta. Bul. 89.

nesota, Iowa, the Dakotas, and Manitoba, dropped as low as -52° F. The injury to apples in the nursery and orchard during that period was widespread and disastrous. Of 57 correspondents who reported that the ground was destitute of snow at the time of this freeze, 43 stated that the principal damage to nursery and orchard trees was to the root; and of 34 correspondents who reported the ground covered with snow, 20 reported that injury was chiefly in the top, while 6 stated expressly that there was no root injury.^a In Iowa young apple trees under 5 years old suffered more than older stock. The effect was most severe on sandy soils not covered with vegetation. The chief cause of the unusual winter injury was thought to be due to the lack of a protecting blanket of snow, coincident with the unusually severe cold. Trees suffered more on clean soils than on exposed dry knolls with northern aspects. To obviate root killing the station recommends as one of the essentials cover crops, preferably mammoth red clover or hairy vetch. The Wisconsin Station^a states that next in value to a snow covering is a covering of litter. Oats, buckwheat, peas, vetches, or mammoth clover are advised as cover crops for this purpose. Mammoth clover is advised only in wet seasons.

Professor Macoun reports that the secret of the successful culture of apples in the more northern regions of Canada, where the extreme range of temperature sometimes varies from -40 to $+104^{\circ}$ F., seems to lie largely in removing the snow from the roots of the trees during winter, so that the ground will freeze to a depth of 4 to 5 inches, after which a mulch of snow and straw is placed at the base of the tree to prevent alternate freezing and thawing before fine weather comes in the spring.^b

Professor Craig^c studied the effect of cover crops on the depth of freezing and obtained the following comparative figures: Bare cultivated ground froze to a depth of 21 inches; under a cover crop of hairy vetch it froze to a depth of 16 inches; under crimson clover, 15 inches; under blue-grass sod, 12 inches, and under soy beans, 21 inches, the latter crop affording no protection whatever. At the Delaware Station ground covered with crimson clover is reported as unfrozen when the temperature of the air was 14° F. In some box experiments carried out by Professor Emerson^d the roots of apple seedlings were much less seriously injured during the winter on ground covered with a 4-inch straw mulch than on bare ground. Not only did the mulch protect the soil from so severe freezing, but also from alternate freezing and thawing. A cover crop that mats down upon the approach of winter, like the hairy vetch or blue-grass sod mentioned above, affords

^a Wisconsin Sta. Bul. 77.

^b Canada Central Expt. Farms Rpts. 1899, p. 89.

^c New York Cornell Sta. Bul. 198.

^d Nebraska Sta. Bul. 79.

much greater protection than one that remains erect, like soy beans. Erect cover crops may, however, shade the ground to some extent and also catch and hold the snow, and a blanket of snow is one of the very best protections against alternate freezing and thawing of the soil.

A cover crop that has quite generally given very satisfactory results throughout the northern States, Canada, and in the South, either alone or in various combinations with other crops, is hairy vetch (*Vicia villosa*). Sown in June or July, at the New York Cornell Station,^a it covered the ground with a dense tangled mulch 2 feet deep. At the New York State Station^b hairy vetch grown with winter rye formed a perfect mat of vegetation which remained green all winter, and the combination did not grow high enough to interfere with the gathering of winter fruit. In Canada hairy vetch has proved especially valuable in dry districts, where it is difficult to get a catch of clover. At the Delaware Station^c it proved very satisfactory, either alone or in combination with a number of other crops. It is a leguminous plant. The total yield of tops and roots at the Delaware Station was 13,750 pounds, which contained 121 pounds of nitrogen, 85 pounds of potash, and 27 pounds of phosphoric acid. At the New York Cornell Station^d the amount of nitrogen yielded by a crop of vetch was 256 pounds. The crop also analyzed over 200 pounds of nitrogen per acre for a growing period of three and a half months. The plant was not very vigorous in the autumn while the shade was dense, but greatly improved later when the leaves began to fall.^e These figures show the great fertilizing value of vetch in addition to its use as a cover crop. In most localities vetch remains green over winter. The objection to vetch is the scarcity and high cost of the seed; but when a small quantity is secured in the beginning the orchardist can easily grow sufficient for his own use.

Crimson clover has been extensively used as a cover crop, with most satisfactory results. In most localities south of New Jersey it lives over winter. At the Delaware Station the total yield of tops and roots averaged 19,213 pounds per acre, and contained 134 pounds of nitrogen. The crop winterkilled at the New York State Station,^f and did not do well on hard clay soil. It gave best results at the Michigan Station^g when seeded in the orchard July 1. The Nova Scotia School of Horticulture^h found a combination of crimson clover and tares a very effective orchard cover crop.

^aNew York Cornell Sta. Bul. 61.

^bNew York State Sta. Rpt. 1896, p. 440.

^cDelaware Sta. Bul. 61.

^dNew York Cornell Sta. Bul. 198.

^eAmer. Agr., 69 (1902), No. 3, p. 79.

^fNew York State Sta. Rpt. 1896, p. 440.

^gMichigan Sta. Rpt. 1898, p. 126.

^hRpt. Sec. Agr. Nova Scotia, 1902, pt. 1, p. 70.

At the Canada Experimental Farms^a red and mammoth clovers sown broadcast at the rate of 12 pounds per acre made the best cover crops for orchards. Common red clover and alfalfa mixed in equal parts have lived over winter and proved better than either alone. On light soils, however, alfalfa seeded at the rate of 15 pounds per acre has done best. The New York State Station^b reports that mammoth red clover formed a dense covering and remained alive over winter at that station, comparing favorably with cover crops of vetch and rye. At the Delaware Station the yield of red clover, including roots, was at the rate of 8,121 pounds per acre, which analyzed 103 pounds of nitrogen. Clover is recommended by the Missouri Station for hill-sides where there is a tendency to washing.

Cowpeas is a favorite orchard cover crop in many of the Southern States. The Whip-poor-will variety is considered one of the most satisfactory sorts in Missouri.^c At the New York State Station cowpeas made a good growth, but were killed by the first frost. At the New York Cornell Station^d the varieties Black and Whip-poor-will proved the most satisfactory sorts. In Delaware the yield of cowpeas, including roots, was at the rate of 6,327 pounds of green material per acre, analyzing about 70 pounds of nitrogen.

The crops thus far considered have all been leguminous crops. They increase the fertility of the soil in nitrogen. Where the soil is already rich in this element it is often desirable to plant some nonleguminous crop, such as rye, oats, buckwheat, rape, turnips, etc. Oats proved very satisfactory at the Michigan Station on heavy clay soils. The crop was easily worked with a disk harrow in the spring, and it is estimated that the cost of cultivating an orchard with this crop was fully one-third less than when crimson clover was sown. Crimson clover seeded with oats was less satisfactory than either alone.^e At the Kansas Station^f oats and cowpeas have been satisfactorily used. Rye and wheat also made heavy growths, but were somewhat difficult to kill by cultivation in the spring, and are therefore considered of less value than either oats or cowpeas. Rape and turnips used as cover crops at the Michigan Station,^g while fairly satisfactory, were unsightly during the winter and gave off an offensive odor. At the New York State Station^b dwarf Essex rape made a very rank growth, not sufficient to interfere with gathering fruit, but furnished a hiding place for mice which girdled some of the trees. At the Delaware Station^g

^a Canada Expt. Farms Rpts. 1900, p. 123.

^b New York State Sta. Rpt. 1896, p. 440.

^c Missouri Fruit Sta. Bul. 4.

^d New York Cornell Sta. Bul. 61.

^e Michigan Sta. Rpt. 1901, p. 110.

^f Kansas Sta. Bul. 106.

^g Delaware Sta. Bul. 61.

cowhorn turnips were successfully used as an orchard cover crop. As a result of extensive experiments at the Delaware Station with cover crops, Professor Close^a recommends the following quantities of seed per acre:

Rye 1 to 1½ bushels; cowhorn turnips 1 to 2 pounds; dwarf Essex rape 8 to 10 pounds; red, mammoth, or crimson clover 15 to 20 pounds; cowpeas 90 pounds; soy beans 90 pounds; hairy vetch 40 to 50 pounds; alfalfa 30 pounds; hairy vetch 40 pounds and rye 30 pounds; hairy vetch 20 pounds and cowpeas or soy beans 45 pounds; hairy vetch 20 pounds and turnips 12 ounces; hairy vetch 20 pounds, crimson clover 8 pounds, and turnips 8 ounces; hairy vetch 20 pounds and red, mammoth, or crimson clover 8 pounds; turnips 8 ounces, rye 20 pounds, and red, mammoth, or crimson clover 4 pounds; turnips 12 ounces and crimson clover 8 pounds; turnips 12 ounces and soy beans or cowpeas 40 pounds; dwarf Essex rape 4 pounds and rye 1 bushel; rape 4 pounds, soy beans or cowpeas 40 pounds, and rye 20 pounds; alfalfa 15 pounds and red, mammoth, or crimson clover 7½ pounds.

FERTILIZING ORCHARDS.

Professor Roberts, of the New York Cornell Station, has reported the results of analyses of the leaves, wood, and fruit of the apple, and discussed them with reference to the amounts of fertilizing elements removed from the soil by an apple orchard in full bearing and by a crop of nursery trees.^a Similar work has also been reported by Shutt^b and Browne, jr.^c The subjoined table shows the percentage composition of the ash of apples and the amount of fertilizers removed from the soil, as calculated by these authorities. The data have been made comparable by assuming in each case an orchard 25 years old, set with 35 trees per acre, and yielding 15 bushels of fruit per tree.

Fertilizers removed by a crop of apples annually.

Authority.	Nitrogen.		Phosphoric acid.		Potash.	
	In whole apple.	Removed yearly per acre.	In whole apple.	Removed yearly per acre.	In whole apple.	Removed yearly per acre.
	<i>Per cent.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>	<i>Per cent.</i>	<i>Pounds.</i>
Roberts	0.130	30.42	0.010	2.50	0.190	47.40
Shutt .....	.043	10.72	.025	6.23	.155	38.65
Browne, jr. ....	.059	14.71	.027	6.73	.168	41.89

In addition to the amount of fertilizers removed by the fruit, an apple tree which had completed its growth and weighed 5,483 pounds (trunk, limbs, roots, and leaves) was found by Roberts^a to contain about 9 pounds nitrogen, 3 pounds phosphoric acid, and 9 pounds potash. With 35 trees per acre this would be equivalent to 315 pounds nitrogen, 105 pounds phosphoric acid, and 315 pounds potash. H. Snyder^d has shown that a crop of spring wheat yielding 18 bushels

^a New York Cornell Sta. Bul. 103.

^c Pennsylvania State Dept. Agr. Bul. 58.

^b Canada Expt. Farms Rpts. 1896, p. 164.

^d Minnesota Sta. Bul. 29.

of grain per acre extracts from the soil 6.5 pounds potash, 12.4 pounds phosphates, and 25 pounds nitrogen. If the straw be added the total amount of these elements removed is 32 pounds potash, 20 pounds phosphates, and 35 pounds nitrogen per acre.

A consideration of all these data indicates that the annual draft of a bearing orchard on soil fertility is fully as great as the annual draft of a good crop of wheat and hence, if it be necessary to fertilize for wheat, it is just as essential to fertilize for apples. Roberts also analyzed thrifty young apple trees from the nursery, and from the data obtained estimated that an acre of nursery apple stock 3 years old would remove from the soil about 29 pounds nitrogen, 10 pounds phosphoric acid, and 20 pounds potash. These are much smaller amounts of fertilizing elements than would be removed by a good crop of wheat in a single year. Similar analyses at the New York State Station^a showed nursery stock to be much less exhaustive on the soil than a crop of grain. The usual failure to raise nursery stock with success continuously on the same land is believed to be due to the fact that the readily available fertilizing materials have been exhausted in the rapid growth of the stock and to the fact that the ground is not always cultivated when it is in the best condition.

At the Iowa Station^b apple twigs of hardy and tender varieties were analyzed to determine whether there exists in midwinter a characteristic difference in the composition of the new growths. The same twigs were also studied microscopically. While some differences were found no definite conclusions could be drawn from the work.

In a study of the moisture content of the twigs of different varieties of apples Shutt^c found that there was a "distinct relationship between the moisture content of the twig and its power to resist the action of frost, and that those trees whose new growth contains the largest percentage of water as winter approaches are in all probability most tender."

The Missouri Station^d also made an examination of apple twigs, analyses being made of the ash of water sprouts and the bearing twigs. Striking differences were found, as is shown in the following table:

Composition of the ash of water sprouts and fruit twigs.

	Lime.	Potash.	Phosphoric acid.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Water sprouts	0.9713	0.9157	0.2916
Fruit twigs	2.2864	.9539	.4651

^a New York State Sta. Rpt. 1892, p. 173.

^b Iowa Sta. Bul. 4.

^c Trans. Roy. Soc. Canada, 3. ser., 9 (1903), Sec. IV, p. 149.

^d Missouri Sta. Rpt. 1898, p. 77.

"Surely the much larger absolute amount of lime, phosphoric acid, and potash in the bearing twigs must be either the cause or condition of their bearing." The Missouri Station also reports the results of analyses of the leaves and peelings of fruit of Ben Davis apple trees that had been fertilized with sulphate of iron. The fruit borne on the trees which had been fertilized with this substance had a much deeper color than that from unfertilized trees, but contrary to expectation the ash of the leaves and peelings contained less sulphate of iron than was found in the leaves and peelings of fruit grown on trees which had not received the sulphate of iron. At Wye College, in England, sulphate of iron used in connection with complete fertilizers had no effect on the color of apples.^a An excess of phosphate resulted in highly colored apples, but there was no noticeable effect on color due either to the absence or excess of potash.

When expensive commercial fertilizers are used in orchards they should be accompanied by thorough tillage and spraying, otherwise the cost of the fertilizers may far exceed the returns from their use. It is only in the best-tilled orchards that commercial fertilizers can be used profitably. Professor Bailey states^b that in his opinion it will not pay to add commercial fertilizers to the general run of fruit plantations in New York. Tillage and other treatment are not good enough to warrant the extra expense. He gives an account of an experiment with a bearing orchard in sod in which one lot of trees was top-dressed with 750 pounds of either muriate or sulphate of potash, but not cultivated. Another plat was given clean cultivation but no fertilizers, while a third plat received both cultivation and 750 pounds of sulphate of potash per acre. Neither tillage alone nor fertilizers alone gave beneficial results, but the two combined resulted in a more vigorous, darker green foliage and better yield. The apples on the cultivated and fertilized plat were 7 to 10 days later than the others and were less highly colored.

Another experiment with an unprofitable orchard 25 years old is recorded. An expert upon examining the orchard thought that it needed potash. Fertilizers were applied to the orchard in August. Some trees were given 10 pounds of nitrate of soda each, others received 10 pounds muriate of potash, others 10 pounds sulphate of potash, and others both muriate and sulphate. The fertilizers were applied as far as the spread of the limbs. They were lightly plowed in and harrowed. No results from the fertilizers were observable the following year, but the second year the foliage of the nitrated trees was remarkably darker and more vigorous than the others and bore a heavier load of fruit. These same results were observable the following year, but in a less degree. The fourth year all effects of the

^a Gard. Chron., 3. ser., 29 (1901), No. 752, p. 332.

^b New York Cornell Sta. Bul. 153.

fertilizers were lost. There was a very slight benefit observable from the use of the potash, but no difference between the two different forms. These results are considered remarkable in showing how difficult it is to make predictions as to the fertilizer requirements of an old orchard and the long time required before the effects of the fertilizers are visible. It was eighteen months before the effects of the nitrate of soda could be seen. In fertilizer experiments with apples on sod at the Massachusetts Station^a marked improvement was observed only when nitrate of soda was used.

At the Maine Experiment Station the use of nitrogenous fertilizers alone greatly increased wood growth, but there was a noticeable lack of color in the fruit. Trees fertilized with acid rock alone did not appear better than those in the check plats. Potash alone, however, produced a distinct improvement.

The same station^b made an experiment to determine the effect of potash fertilizers on the development of apple scab. The muriate of potash, sulphate of potash, and kainit, respectively, were used on the different plats at the rate of 1,000 pounds per acre over an area of 15 feet radius around each tree. The orchard was about 25 years old when the experiment began in 1898, and each year since then the trees have been regularly fertilized as noted. The detailed results obtained need not be given, but they show clearly "that an excess of potash in whatever form applied has no effect whatever in warding off attacks of the apple scab."

The New York State Station^c in some experiments extending over five years also found that potash in the form of wood ashes used at the rate of 100 pounds per tree each season had no apparent effect in decreasing apple scab. In these experiments it was found that the color of the fruits of some varieties in some seasons was much improved by the use of ashes. In seasons which favored the perfect development of the fruit, however, none of the varieties showed any improvement in color due to the use of the ashes. "Apparently the use of ashes had a general tendency to hasten the perfect development of the fruit. When the season was not especially favorable to perfect development of the fruit it improved the keeping quality, but in a season very favorable to the perfect development of the fruit the ripening processes were generally carried so far where the ashes were used that the apples did not keep so well as where no ashes were used." At the Rhode Island Station^d an old, neglected, moss-grown, and unprofitable orchard was converted within three years into a thrifty, paying orchard by ordinary attention to fertilizing, spraying, pruning, and tilling.

No general conclusions can be drawn from the fertilizer work thus far reported other than that an orchard in full bearing is as exhaustive

^aMassachusetts Sta. Bul. 66.

^cNew York State Sta. Bul. 140.

^bMaine Sta. Bul. 89.

^dRhode Island Sta. Bul. 83.

on the soil as any of the ordinary farm crops, and should, therefore, be as regularly fertilized as other crops. The application of commercial fertilizers without cultivation is likely to be a complete loss. The two should go together. Fertilizers and cultivation appear to delay the ripening period a week to ten days. Nitrogen is more often needed in orchards than is generally supposed. Its use alone results in less highly colored fruits. Neither potash nor sulphate of iron appears to be the cause of high color in fruit, while there is some evidence that phosphoric acid in excess may conduce to high color. Fruit twigs are much richer in mineral elements than water sprouts.

GIRDLING TO PRODUCE FRUITFULNESS.

The Massachusetts Hatch Station^a reports an experiment in which three crab-apple trees were girdled to determine its effect on fruitfulness. A ring of bark, varying from one-eighth to one-half inch wide, was removed from the trees in some instances just at the ground, in others just below the main branches, and in still others on one or more of the main branches. All the girdles made near the ground healed over readily and completely. Those on the main trunk healed less completely, but sufficiently to insure a good growth of tree, while some of the girdled branches died. All the trees showed a marked increase in fruitfulness over those not girdled. No conclusions are drawn from this experiment, but it is pointed out that girdling may be of value in throwing rank-growing trees on very rich, moist soil into bearing.

THINNING.

In order to determine the value of thinning apples, the Massachusetts Hatch Station^b selected two Gravenstein trees, each of which had made a heavy set of fruit. The thinned tree yielded 7 bushels of first-class apples, 1 bushel of second-class, and $9\frac{1}{2}$ bushels of windfalls. The unthinned trees yielded $2\frac{1}{2}$ bushels of first-grade fruit, $2\frac{1}{2}$ bushels of second-grade, and $10\frac{1}{2}$ bushels of windfalls. The cost of thinning was 48 cents per tree, and the market value of the thinned fruit \$4.45, and of the unthinned tree but \$2.12. Similar results were also obtained on thinned and unthinned Tetofsky trees. In another experiment in thinning Red Astrakhan, Baldwin, and Rhode Island Greening the profits from thinning varied from 55 cents to \$2.05 per tree, the greatest average profit being obtained from thinning Red Astrakhan. The yields of these varieties were slightly increased by thinning, but with the varieties Early Harvest and Hurlbut, the yields were practically the same on the thinned and unthinned trees.

^aMassachusetts Hatch Stat. Bul. 1.

^bMassachusetts Hatch Stat. Bul. 44.

Experiments at the New York State Station^a in thinning Baldwin, Hubbardston, and Rhode Island Greening apples for four seasons indicate that in seasons when heavy crops are borne thinning the fruit heightens the color and increases the size. When only a small crop of fruit is set, thinning has no appreciable influence on either color or size. The experiments with all three varieties of apples were fairly uniform in showing no tendency on the part of the trees which had been regularly thinned to produce larger crops or to bear more regularly than trees not thinned. The thinned trees bore a larger percentage of first-grade fruit than unthinned trees, and the fruit was much better adapted for making fancy grades. From a commercial standpoint, the gist of the experiments is contained in the opinion of the practical grower in whose orchard the experiments were conducted, to the effect that, when there is a heavy set of apples and the likelihood of a large crop of small fruit, generally it will pay to thin to such an extent as to insure good-sized fruit; otherwise not, except as a protection to the tree. It is believed that the cost of thinning a well-loaded apple tree should not exceed 50 cents.

At the Delaware Station^b apples on heavily loaded Lankford trees were thinned 4 to 6 inches apart, after first removing all inferior and wormy specimens. At harvest time the thinned trees yielded from one and one-half to three times as much first-grade picked fruit as did the unthinned trees, while the yield of second and third-grade picked fruit was greatest on the unthinned trees. The thinned trees gave from three to seven times as much first-grade dropped fruit as did the unthinned trees, while the yield of second-grade dropped fruit was greater under the unthinned trees. The total yield from the thinned trees averaged about the same as from the unthinned trees.

HARVESTING AND STORING APPLES.

Chemical analyses by C. A. Browne, jr.,^c show that, after apples have reached their maximum size and weight, they receive no further nourishment from the tree and may be picked and will ripen just as well as if allowed to remain on the tree. It is the general experience of growers that apples picked when fully matured, but still hard and carefully stored, keep better and develop a finer flavor than when allowed to ripen on the tree. The keeping qualities of apples appear to be greatly influenced by their condition when picked, the temperature at which they are kept in storage, methods of handling, etc.

The keeping quality of different varieties of apples also varies greatly. As a result of experiments in storing a number of varieties

^a New York State Sta. Bul. 239.

^b Delaware Sta. Rpt. 1902, p. 91.

^c Pennsylvania State Dept. Agr. Bul. 58.

of apples in a cellar at the Maine Station^a the following conclusions were reached relative to varieties:

Dudley, Haas, and most of the Russian varieties are comparatively poor keepers and should be used before January. Borsdorf, Longfield, Pewaukee, Porter, and Shiawassee are at their best before the 1st of February, though keeping well into March. Hurlbut, Milding, and Munson Sweet begin to break down in March; the latter is in good condition from October to this date. Arctic, Bethel, Boiken, Mann, Northwestern Greening, Rall Janet, Stark, Westfield, and Winesap are in prime condition up to April 1. Munson Sweet, Porter, and Shiawassee showed most surprising results, and indicate that with care these sorts may be kept much longer than is generally supposed. Peter, which became too soft for market in January, made very good pies as late as the end of March.

The Ohio Station^b has reported an experiment to determine the effect on the keeping quality of picking apples at four different periods between September 26 and October 20. The difference in keeping quality became decided only after nearly six months. The early picked fruit lost slightly more in weight than late-picked fruit.

The Illinois Station^c also investigated the degree of maturity most suitable for picking apples to be held in cold storage. The results obtained indicate a great superiority in the keeping quality of mature over immature fruits. The mature fruit in storage showed a much smaller percentage of rot, was less subject to scald, did not shrink as much, had better color and better selling qualities when removed from storage. The same station^d erected a cold-storage building capable of holding 2,500 barrels of fruit and costing \$3,080.41. With 70 tons of ice placed in the building the temperature was maintained at 33° F., or a little lower, for about seven months, and the cost of storage averaged about 19.1 cents per barrel. Without exception the fruit in this building kept well. "There was no scald, no withering, the fruit remained plump and in perfect condition, and the percentage of rotten fruits was very small." The results are believed to plainly show the utility of buildings of this character cooled by ice. "Commercial growers of apples can well afford to invest in similar storage houses and thus add greatly to their profits." Other experiments by the same station show pretty clearly that horticulturists in southern Illinois at least can not afford to insulate a cellar for storing fruit; the earth proved too good a conductor of both heat and cold and a uniform temperature could not be maintained. Fruit stored in such cellars was more or less wilted and the percentage of rot quite high.

Experiments reported by the Iowa Station^e indicate that the varieties McMahan White, Northern Spy, Pewaukee, Roman Stem, Seek-No-Further, White Pippin, and Wolf River possess poor keeping qualities and are not suitable for storing in cold storage in that State.

^a Maine Sta. Bul. 82.

^b Ohio Sta. Bul., Vol. II, No. 4.

^c Illinois Sta. Circ. 67.

^d Illinois Sta. Circs. 44 and 67.

^e Iowa Sta. Bul. 72.

Especially satisfactory results were secured in the cold storage of Fameuse and Wealthy, both of which kept well until March. The results secured with these two fruits are believed to be of great value to the apple growers of Iowa, since they are hardy throughout the State, productive, and of excellent quality. Other standard varieties that kept well in cold storage were Ben Davis, Dominic or Wells, Janet, Romanite, and Willow Twig.

Many experiments have been made to determine the value of wrapping apples kept over winter either in an ordinary cellar or in cold storage. At the New Hampshire Station^a it was found that wrapped apples kept considerably better than unwrapped, particularly during the later months of storage. But little difference was noted until March 1. The Colorado State Board of Horticulture^b has published the results of a test of the comparative value of wrapping apples and of storing them without wrapping. Both the wrapped and unwrapped fruit were placed in cold storage in the fall. The following June fully 70 per cent of the unwrapped apples were decayed, and those remaining in firm condition were so badly discolored and had lost flavor to such an extent as to render them wholly unfit for either show or market. In this experiment the apples were wrapped first in a sheet of wax paper and then in common news paper. When only common news paper was used to wrap the fruit about 30 per cent was in very poor condition June 1, while varieties picked and stored at the same time, using the double wrapping of wax sheets and common paper, remained in almost perfect condition as late as November 1. Of four different forms of wrapping material used at the New Hampshire Station, namely, heavy wax manila, thin wax manila, plain manila tissue, and news paper, but very little difference was noticed in the effectiveness of the different wrappings, and it is believed that clean news paper is as good as the more expensive forms.

In a test reported by the Central Experimental Farms of Canada^c of wrapped versus unwrapped fruit, the wrapped fruit kept best. There were fewer rotten apples and they lost least by evaporation.

At the West Virginia Station^d fruit kept in cold storage in the light, with the exception of York Imperial, lost more in weight than fruit in darkness. There was also a slightly greater loss of weight in apples stored in open barrels than those stored in headed barrels. The same station also states that practical experience in that State has shown that the later the Willow and Rome Beauty can be placed in cold storage without being actually frozen on the trees the better they will keep.

^a New Hampshire Sta. Bul. 93.

^b Colorado State Bd. Hort. Rpt. 1898, p. 39.

^c Canada Cent. Expt. Farm Rpt. 1897.

^d West Virginia Sta. Bul. 74.

The New Hampshire Station^a experiments show that when apples are kept in storage certain chemical changes take place which are independent of decay and which result in the overripe condition recognized by mealy pulp and lack of flavor. "Low temperatures hinder the chemical changes while high temperatures hasten them. Apples intended for cold storage should be carefully handled and placed in the storehouse as soon as possible after picking." For best results in the cold storage for apples a constant temperature as near freezing point as possible is generally recommended.

The conclusions of G. H. Powell and S. H. Fulton, of this Department, who made very extensive studies on the cold storage of apples, are in part as follows:^b

An apple usually should be fully grown and highly colored when picked, to give it the best keeping and commercial qualities. When harvested in that condition it is less liable to scald, of better quality, more attractive in appearance, and is worth more money than when it is picked in greener condition. An exception to the statement appears to exist in the case of certain varieties when borne on rapidly growing young trees. Such fruit is likely to be overgrown, and under these conditions the apples may need picking before they reach their highest color and full development.

Uniform color may be secured by pruning to let the sunlight into the tree, by cultural conditions that check the growth of the tree early in the fall, and by picking over the trees several times, taking the apples in each picking that have attained the desired degree of color and size.

Apples should be stored as quickly as possible after picking. The fruit ripens rapidly after it is picked, especially if the weather is hot. The ripening which takes place between the time of picking and storage shortens the life of the fruit in the storage house. The fruit rots multiply rapidly if storage is delayed and the fruit becomes heated. If the weather is cool enough to prevent after ripening, a delay in the storage of the fruit may not be injurious to its keeping quality. A temperature of 31° to 32° F. retards the ripening processes more than a higher temperature. This temperature favors the fruit in other respects. A fruit wrapper retards the ripening of the fruit; it preserves its bright color, checks transpiration and lessens wilting, protects the apple from bruising, and prevents the spread of fungus spores from decayed to perfect fruit. In commercial practice the use of the wrapper may be advisable on the finest grades of fruit that are placed on the market in small packages.

Apples that are to be stored for any length of time should be placed in closed packages. Fruit in ventilated packages is likely to be injured by wilting. Delicate fruit and fruit on which the ripening processes need to be quickly checked should be stored in the smallest practicable commercial package. The fruit cools more rapidly in small packages. Apples should be in a firm condition when taken from storage, and kept in a low temperature after removal. A high temperature hastens decomposition and develops scald. The best fruit keeps best in storage. When the crop is light it may pay to store fruit of inferior grade, but in this case the grades should be established when the fruit is picked. The bruising of the fruit leads to premature decay.

The scald is probably caused by a ferment or enzyme which works most rapidly in a high temperature. * * * From the practical standpoint the scald may be pre-

^aNew Hampshire Sta. Bul. 93.

^bU. S. Dept. Agr., Bureau of Plant Industry Bul. 48.

vented to the greatest extent by producing highly-colored, well-developed fruit, by storing it as soon as it is picked in a temperature of 31° to 32° F., by removing it from storage while it is still free from scald, and by holding it after removal in the coolest possible temperature.

A variety may differ in its keeping quality when grown in different parts of the country. It may vary when grown in the same locality under different cultural conditions. The character of the soil, the age of the trees, the care of the orchard—all of these factors modify the growth of the tree and fruit and may affect the keeping quality of the apples. The character of the season also modifies the keeping power of the fruit.

COMPOSITION.

The composition of the flesh of 25 varieties of perfectly ripe, sound, unwilted apples was found by C. A. Browne, jr.,^a to average about 84 per cent water, 12 per cent sugar, 0.6 per cent free malic acid, and 0.3 per cent ash. The water content of the apples varied in the different varieties from 76.6 per cent to 86.2 per cent, and the total sugar from 9.6 per cent to 16.8 per cent. Seven varieties of California apples^b averaged 86 per cent water and 11.62 per cent sugar. Prof. W. R. Lazenby, of the Ohio Station,^c found from the analyses of a large number of varieties that apples of the best quality are the ones containing the largest amount of water, while small, runty apples of inferior quality contained the least amount. In preparing apples for the table Professor Lazenby also found that the waste of 25 varieties as purchased in the open market averaged about 24 per cent, but with select specimens the waste might be as low as 10 per cent.

Inferior specimens of apples appear to draw more heavily on the mineral constituents of the soil than the better grades, as shown by analyses reported by the Missouri Station.^d Large ripe specimens of Ben Davis, averaging 3½ inches in diameter, contained 7 pounds of phosphoric acid and 37 pounds of potash per acre, while smaller ripe specimens 2½ inches in diameter contained 7½ pounds phosphoric acid and 43 pounds potash per acre. This is based on the estimate of 10 bushels of fruit per tree and the trees spaced 30 feet apart each way.

Unripe apples contain considerable amounts of starch and less sugar than ripe apples. Thus C. A. Browne, jr.,^a found that very green Baldwin apples contained, August 7, 4.14 per cent starch and 8.11 per cent sugar. Five weeks later they contained 3.67 per cent starch and 10.72 per cent sugar. Two months later when ripe they contained but 0.17 per cent starch and 14.87 per cent sugar. Perfectly ripe apples contain no starch whatever. In the after-ripening of apples, C. A. Browne, jr., found that the chemical changes that take place are mainly

^a Pennsylvania State Dept. Agr. Bul. 58.

^b California Sta. Rpt. 1898, p. 143.

^c Proc. Soc. Prom. Agr. Sci., 1903, p. 105.

^d Missouri Sta. Bul. 10.

as follows: The residual starch is changed into sucrose or cane sugar in the first stage, next the cane sugar is changed into invert sugar, and finally there is a slow decrease in total sugar. The acid which is most abundant in the green fruit gradually decreases with ripening.

When apples were gathered before they were ripe and stored or allowed to sweat in piles, R. Otto^a found that the starch in them was entirely converted into sugar within 2 to 3 weeks. The sweating of apples is, therefore, believed to be very advantageous in cider making and especially desirable with apples not yet fully ripe, since such apples contain comparatively large amounts of starch which needs to be converted into sugar for the manufacture of good cider.

The apples must not be allowed to lie too long, however, after the starch has become converted into sugar. Fruit under a bell jar in the experiment mentioned above increased in sugar content from 9.98 to 11.51 per cent within 23 days, but after 49 days it had again decreased to 10.4 per cent.

The composition of the apple has also been found to vary with the different seasons. Thus R. Otto^b gives the results of the analyses of 18 varieties of apples harvested in the fall of 1898 and of the same varieties harvested in 1900. The average monthly precipitation in 1898 for the months March to October, inclusive, was 58.6 millimeters, while in 1900 it was 61.4 millimeters. There was also 281.7° C. more heat during the months of June, July, September, and October in 1900 than in 1898. As a result of these different climatic conditions two-thirds of the varieties ripened considerably earlier in 1900 than in 1898—in many cases 2 weeks and in some cases 22 and 45 days earlier. The specific gravity of the musts of half of the varieties was considerably higher in 1900 than in 1898. With 13 of the 18 varieties there was a considerable increase in the sugar content and a decrease in the acid content in 1900 as compared with 1898. The difference in rainfall and temperature in 1900 was believed to largely account for the earlier ripening and the differences in the chemical composition of the apples.

UTILIZATION OF WASTE APPLES.

But few experiments have been made along this line at the stations. The Virginia Station reports^c that with a hand grinder and press only about 2 gallons of cider could be obtained per bushel of apples. With apples at 8 cents per bushel cider made in this way cost 6 cents per gallon. With a medium-sized custom grinder and press run with an 8-horsepower engine, cider was produced at a cost of 2.3 cents per gallon, and 4 gallons were obtained per bushel of apples. A jelly

^aProskauer Obstbau Ztg., 7 (1902), No. 10, p. 156.

^bLandw. Jahrb., 31 (1902), No. 4, pp. 605-618.

^cVirginia Sta. Bul. 57.

suitable for table use made by adding 1 pound of sugar to 5 pounds of cider, cost for material about 3 cents per pound of finished product, 40 pounds of jelly being made per 100 pounds of cider. A better quality of apples was found necessary for marmalade than for cider. It was found advantageous to cook apples in cider rather than water. With apples at 20 cents per bushel, marmalade cost for material less than 2 cents per pound of finished product, an average of 116 pounds being made from 80 pounds sliced fruit, 8 gallons fresh cider, and 35 pounds of sugar. The loss from coring and paring the apples averaged 25.4 per cent, while in the case of unpared fruit the colander removed not over 5 per cent.

At the Central Experimental Farm of Canada^a some experiments were made in evaporating apples. Samples of 47 varieties of apples were evaporated without sulphuring in a family evaporator. The temperature ranged between 200 and 210° F. Patten Greening furnished 16 pounds of evaporated product per bushel of fruit. This was the largest amount obtained from any variety. Following this came Baxter 10 pounds per bushel, Ben Davis 9.4 pounds, Golden Russet 9.4 pounds, Northern Spy 9.7 pounds, King 9 pounds, Ribston Pippin 9 pounds, Twenty Ounce 9.4 pounds, and Pewaukee 7.6 pounds. The flesh of some varieties quickly turned brown on being cut, while others did not discolor as rapidly or to as great an extent. Sulphuring largely overcame this defect, but it is held that an apple whose cut surface dries white instead of brown is to be preferred. Varieties that retained their color well were Baxter, Duke of Connaught, Lawyer, Missouri Pippin, and Walbridge.

In these experiments the best apples for evaporating were found to be those still firm and somewhat green. Such apples produce a product of better texture and flavor than apples ripe enough for dessert.

The Massachusetts Hatch Station^b has also reported the results of some work in evaporating apples. Varieties producing the best quality of product were Swaar, Snow, Ben Davis, Hurlbut, Baldwin, and Willow Twig; second quality, Westfield (Seek-No-Further), Rhode Island Greening, and Red Russet. The average result secured in this experiment was about 6½ pounds of evaporated fruit per bushel of apples. The use of sound fresh fruit gave a larger and better product than overripe fruit. In preparing the fruit it was first dropped into salt water and then subjected for a few minutes to the fumes of sulphur in order to bleach it. Analysis showed that only one-fifth to one-thirtieth of 1 per cent of sulphurous acid was found in the fruit, an amount considered entirely harmless, most of which would wash out in preparation for cooking.

^aCanada Expt. Farms Rpt. 1896, p. 160.

^bMassachusetts Hatch Sta. Rpt. 1894, p. 20.

The North Carolina Station^a believes it is much more advantageous to evaporate apples than to sun-dry them, since evaporated apples sell for about 6 cents per pound in the market, while sun-dried apples bring only $2\frac{1}{2}$ to $3\frac{1}{2}$ cents. A profitable evaporator should have a capacity of not less than 300 pounds of dried fruit per day. The same station deprecates the bleaching of fruits by fumes of burning sulphur, and suggests instead that they be dropped into a tub of weak salt brine made in the proportion of 1 pound of clean table salt to 10 gallons of water and boiled together for 10 minutes.

^aNorth Carolina Sta. Bul. 182.

PROGRESS IN AGRICULTURAL EDUCATION, 1903.

By A. C. TRUE,

Director of the Office of Experiment Stations.

EDUCATIONAL WORK OF THE DEPARTMENT OF AGRICULTURE.

In his annual report for 1903, the Secretary of Agriculture called attention to the large work which the Department of Agriculture is doing in training agricultural experts, taking for this purpose students and graduates from the agricultural and other colleges and giving them special instruction in connection with the research work of the Department.

The Department has thus become a post-graduate institution, where groups of sciences are taught and applied. Comparatively little time is devoted to the ascertainment of abstract scientific facts. Every worker is helping somebody, and while doing this he is contributing to what is known relating to the farm and to the education of his associates.

Four hundred and ninety-six students have been admitted to the Department for instruction since 1897 as experts in our several lines of work. Two hundred and forty-nine of these still remain with us, not less than 132 having passed into the classified service, 185 having gone elsewhere to teach, experiment, or demonstrate in private enterprise what they have learned from their teachers, who are our best-equipped scientists in their several specialties. * * *

The Weather Bureau has, through its officials at the various stations throughout the country, taken an active part in public education along meteorological lines. In 12 colleges or universities during the past year Weather Bureau officials have conducted regular courses of lectures or classes of instruction in meteorology and climatology, and at 5 of these institutions the official is a member of the faculty. At 16 stations the officials have delivered occasional addresses outside of their offices to schools or colleges, and at 28 stations they have given frequent talks in their offices to pupils and teachers of schools. In 14 instances they have delivered occasional addresses outside of their offices to farmers' institutes and similar organizations. Only a few years ago there was very little instruction of this nature given in our colleges, universities, or public schools, but the demand for it has rapidly increased. The action of the Bureau in this direction will undoubtedly result in a wider knowledge and a more intelligent understanding of its work, and a consequent increase in its usefulness and value. Many of the young men who receive instruction in these classes are attracted to the service of the Bureau as an occupation, and the Bureau profits by securing a class of employees with special training and equipment. * * *

This Department has been aiding the school-garden movement in several ways. Through the Bureau of Plant Industry it has distributed special packages of vegetable and flower seeds to a large number of schools, and conducted a number of school-gardening experiments in cooperation with the schools and charitable organizations

of Washington, D. C. Officers of the Department have in several instances volunteered to direct these experiments outside of office hours. One of the most successful of these experiments was conducted on the Department grounds with a class of 30 boys and girls from a near-by school, under the direction of the science teacher in the normal school of the city.

The publications of the Department during the past year were issued in larger numbers and were more widely distributed than ever before. The total number of publications issued in 1903 was 938, as compared with 757 in 1902. The total number of copies of all publications issued in 1903 aggregated not far from 12,000,000, of which about 7,000,000 were farmers' bulletins. Undoubtedly the educational influence of this immense volume of literature on our agricultural population generally is very great, but it is also noteworthy that the number of Department publications sent directly to schools in the cities as well as in the country districts is already large and is steadily increasing.

EDUCATIONAL WORK OF THE OFFICE OF EXPERIMENT STATIONS.

While the other Bureaus of the Department have done valuable educational work along the lines of research in which they are engaged, the Office of Experiment Stations has continued to act as a general agency for the promotion of agricultural education throughout the United States, and has enlarged the scope and extent of this branch of its work during the past year. Special attention is being given to the better organization of our system of agricultural education, so that it may include properly graded courses of instruction reaching from the graduate school and the college to the common schools, and may embrace all the branches of agriculture considered as both a science and an art. Part of this work is being done in cooperation with the Association of American Agricultural Colleges and Experiment Stations, the Director of this Office being chairman of the standing committee on methods of teaching agriculture. During the past year there have been an unusual number of opportunities to present the claims of agricultural education through public addresses, and in this way representatives of this Office have urged this matter on the attention of a considerable number of public men, educators, students, and influential farmers in different States.

As regards the agricultural colleges, the Office has especially endeavored during the past year to aid the movement for the development of courses in rural engineering, the establishment of courses in that branch of this subject entitled farm mechanics being particularly agitated in the colleges at this time. An account of the progress thus far made in this line in our colleges is given later in this report. Some attention is now being given to rural economics, a subject which is beginning to take more definite pedagogical form in a few of our colleges, and which should be more extensively studied and taught in

this country. To stimulate the more thorough organization and equipment of the college courses in agronomy, a bulletin showing what has been done in this branch of agriculture at a number of our leading colleges was issued during the past year and has been very favorably received. Many of the colleges are offering short and special courses to meet the needs of students who are unable to take the regular courses. To meet the demand for information regarding these limited courses this Office has prepared a bulletin describing them as they now exist in the several States.

Following the publication of the outline secondary courses in agriculture prepared by the committee on methods of teaching agriculture (Office of Experiment Stations Circ. 49), an article on the progress in secondary education in agriculture was furnished for the Department Yearbook for 1902, and the importance of this subject was thus presented to a wide circle of readers. By public addresses, correspondence, and personal conferences active efforts are being made to promote the movement for the establishment of secondary schools and courses in agriculture in different parts of the country.

As regards the elementary schools, the efforts of this Office have taken two directions—(1) to aid the already active movement for the spread of nature-study courses in city and country schools and the establishment of school gardens in connection with such courses, and (2) to promote the formulation and introduction of elementary courses in agriculture especially suited to the rural schools. Mr. D. J. Crosby is giving special attention to this branch of our work. Along these lines addresses have been given at the State teachers' associations in New York and New Hampshire; ten teachers' institutes in Missouri; the summer school for teachers at the Connecticut Agricultural College; the teachers of the District of Columbia; the assembly at Chautauqua, N. Y.; the Brookline, Mass., Education Association; the Kent Improvement Association at East Greenwich, R. I., and the Maine State Pomological Society at Winthrop, Me.; and in this way over 3,000 teachers were reached. A large correspondence on this subject has also been carried on and numerous publications have been distributed.

REPORT ON SCHOOL GARDENS.

Acting as chairman of a committee on school grounds for the American Park and Outdoor Art Association, Mr. Crosby prepared a report which was presented at the convention of that association at Buffalo, N. Y., in July, 1903. That portion of this report which relates to school gardens is given herewith.

With reference to the planting of trees and shrubbery it has been found that in many, probably the majority of instances, this work has gone hand in hand with the establishment of school gardens—flower

and vegetable gardens. It has been found a fruitful source of instruction in nature study, a means for arousing and developing an appreciation of the beautiful in outdoor art, and its influence has in nearly all cases extended to the homes of the children, with the result that many efforts have been made to improve the external appearance of these homes. Efforts along this line are not by any means general, but interest in the work is active, especially in the North Atlantic and North Central States. It should be fostered and encouraged wherever a member of this association or any of its auxiliaries can be found.

School gardens—meaning by the term flower and vegetable gardens utilized for educational purposes—are more numerous, or at least more of them have been reported to your committee. They are found in the East, the Middle West, the South, the far West, and our insular possessions. They are maintained in connection with the kindergarten, and with every other grade up to the high school. However, the really significant and permanently valuable feature of recent progress in this connection lies not so much in the extent of the movement or in the grade of instruction as in the fact that school gardens are being started in connection with 15 or 20 normal schools, that the officers of 10 or 12 agricultural colleges are preparing school-garden plans and courses and otherwise cooperating in the work, and that departments of public instruction all over the United States are displaying much interest and activity in the school-garden movement. In this way preparation is being made for putting school-garden instruction on a pedagogical basis. Nearly every new educational movement has its fad or sprout stage, during which it makes a luxuriant growth in the sunshine of popular favor, and is only saved from breaking down of its own weight by the level-headed few who possess not only enthusiasm but the necessary native ability and persistence to make the thing succeed. This is followed by a period of reaction, of cutting back, during which if unworthy it dies, or if worthy takes root deep in the rich earth of our existing educational institutions and prepares for a less showy but strong and vigorous growth. It is encouraging, therefore, to note that so many of our leading educational institutions are already preparing to give adequate and intelligent support to the school-garden movement, to prepare teachers who shall be able to make the school garden truly an educational feature of the school.

PLANTING TREES AND ORNAMENTALS FOR THE IMPROVEMENT OF SCHOOL GROUNDS.

One of the most active agencies for the improvement of school grounds, both urban and rural, is the Bureau of Nature Study of Cornell University. For a number of years this bureau has been working among the children of the State through Junior Naturalist

Clubs, the total membership of which includes over 18,000 pupils in the public schools. Each member is reached through the Junior Naturalist Monthly and by correspondence through the school-teachers. A little over a year ago the bureau decided to put this vast machinery into operation for the improvement of school grounds.

The State superintendent of public instruction and other influential persons have lent their support to the movement. The result has been the awakening of a general interest in the improvement of school grounds and the actual realization of much better conditions in many rural and city schools. During the past year 2,400 children wrote to the supervisor of the bureau telling what they had done for the betterment of 475 school premises.

In Rochester the efforts of the Women's Educational and Industrial Union for the improvement of school grounds antedated the efforts of the bureau in this direction one year. Many of the school children undertook to improve their surroundings. (Pl. XXX, fig. 1.) The Rochester Post-Express sums up the results in the following paragraph:

Green turf has taken the place of bare clayey banks, and shrubs and flowers grow where the burdock and tomato can flourished in days gone by. The windows of the schools are filled with ferns and flowering plants, and the interest taken in the school yard has extended to the home surroundings—to the betterment of whole neighborhoods.

Similar work has been done in a number of schools in Cleveland, Ohio, under the auspices of the Home Gardening Association (Pl. XXX, fig. 2); in Washington, D. C. (Pl. XXX, fig. 3); in Detroit, and in numerous other cities. In most cases the work has been accomplished with so little ostentation that outside attention has not been attracted, but its influence has been none the less elevating and helpful not only to the pupils but also to the homes of the pupils.

FLOWER AND VEGETABLE GARDENS AS SOURCES FOR NATURE-STUDY MATERIAL AND OUTDOOR MANUAL TRAINING.

NORTH ATLANTIC STATES.

In the North Atlantic States Massachusetts and Connecticut have made greatest progress in the establishment of school gardens. In Massachusetts Boston continues to be the center of the school-garden movement. Here the work was started twelve years ago in connection with the George Putnam Grammar School (Pl. XXXI, fig. 1), and has been continued with marked success up to the present time. For ten years the work was confined to native wild flowers and ferns, but since 1900 vegetable gardens have been made a prominent feature of the work.

About three years ago the Boston Normal School began similar work with vegetables on a vacant lot at the corner of Dartmouth street and Warren avenue. At this place boys from the Rice Training

School and girls from the Franklin School had individual gardens under the supervision of a science teacher in the normal school, who was assisted by her normal students. This work has succeeded admirably, not only in furnishing garden work for the pupils of these two schools, but also in providing training for prospective teachers. This year three graduates of the normal school have been put in charge of school-garden work in seven of the other city schools, and a fourth graduate has charge of gardens in connection with several of the schools at Brookline.

Another notable enterprise of this kind in Boston is the Hale House Farm. Hale House is a social settlement in Boston, the officers of which procured last summer several acres of ground at Watertown, one hour out by street car, where 12 of the boys erected a small cottage in which they could stay nights and Sundays. Most of the boys were at work during the day, so their time at the farm was limited. However, they planted potatoes, peas, beans, corn, watermelons, muskmelons, squash, cucumbers, lettuce, and beets, and succeeded in producing some very good vegetables. The enterprise is being continued this year with prospects of even greater success than attended last year's efforts.

In the vicinity of Boston several towns have inaugurated work on the plan originally followed at the George Putnam Grammar School. Medford has three such gardens and Wenham five. East Dedham, on the other hand, is branching out on original lines. A new school-house is just being built and a progressive school board has employed a landscape architect to take charge of the planting, with the result that the grounds are to be provided not only with shade trees, shrubbery, and playgrounds, but also with a botanic and flower garden, a rockery, a vegetable garden with individual plats for a large number of pupils, and a nursery for growing trees and shrubs. (Pl. XXXII.)

In the public schools of Worcester the raising of plants has been substituted for the old-time work in botanical analysis. Gardening, however, is only one of the many valuable features of nature-study work conducted in these schools. At Groton school-garden work has been conducted in connection with the School of Horticulture and Landscape Gardening for Women.

At least two of the normal schools of Massachusetts, viz, those at Hyannis and Framingham, have incorporated school-garden work in their practice schools to give their normal students training in conducting work of this kind. At Hyannis the garden work is made the basis for numerous exercises in connection with the mathematics, bookkeeping, business training, drawing, and language work of the school. The children write letters to the seedsmen from whom they purchase seeds, sell their produce, deposit money in the bank, make purchases and pay for them with checks drawn on their account,



FIG. 1.—AGRICULTURAL EDUCATION—LAWN AND SHRUBBERY PLANTED BY SCHOOL CHILDREN AT SIDE OF A SCHOOL BUILDING IN ROCHESTER.



FIG. 2.—AGRICULTURAL EDUCATION—ROCKWELL SCHOOL, CLEVELAND. LAWN AND FLOWER BEDS MADE BY SCHOOL CHILDREN.



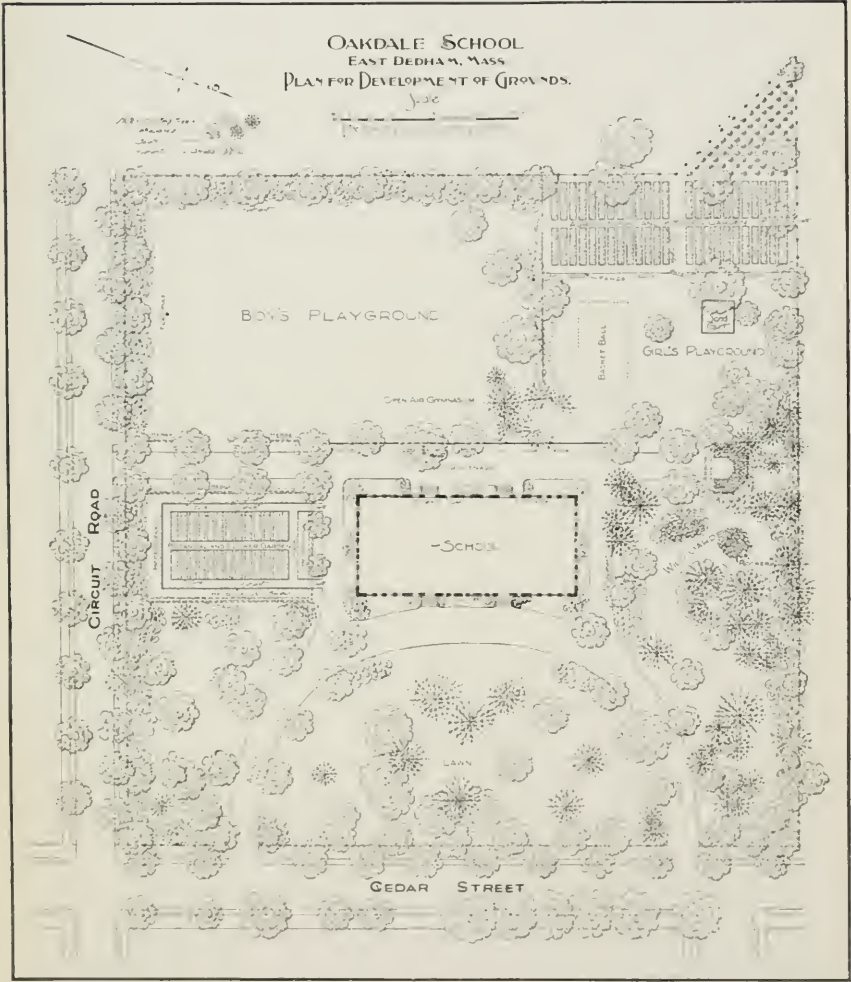
FIG. 3.—AGRICULTURAL EDUCATION—SCHOOL AND HOME GROUND IMPROVEMENT. BACK YARD CARED FOR BY WASHINGTON NORMAL SCHOOL STUDENT



FIG. 1.—AGRICULTURAL EDUCATION—GEORGE PUTNAM SCHOOL GARDENS, BOSTON.



FIG. 2.—AGRICULTURAL EDUCATION—GIRLS' GARDENS AT HARTFORD SCHOOL OF HORTICULTURE.



AGRICULTURAL EDUCATION PLAN FOR DEVELOPMENT OF OAKDALE SCHOOL GROUNDS, EAST DEDHAM, MASS.



FIG. 1.—AGRICULTURAL EDUCATION—STATE NORMAL SCHOOL, JOHNSON, VT. POTATOES RAISED BY CHILDREN IN THE PRACTICE SCHOOL.



FIG. 2.—AGRICULTURAL EDUCATION—A SCHOOL GARDEN AT DEWITT CLINTON PARK, IN THE HEART OF NEW YORK CITY

Connecticut has its school of horticulture at Hartford, and school gardens in connection with the normal school at Willimantic, several of the schools at Hartford, and the school at West Hartford. The school of horticulture (Pl. XXXI, fig. 2), maintains the largest number of gardens of considerable size of any institution in the country. There are 166 gardens apportioned as follows: For teachers, 24 gardens, each 10 by 30 feet; for boys and girls, 125 gardens, each 10 by 25 feet, for first-year pupils; 16 gardens, each 10 by 30 feet, for second-year pupils, and 1 garden, 10 by 40 feet, for a third-year pupil. The pupils are drawn largely from the city schools and have one hour a week in the gardens. The second-year pupils also have root grafting and greenhouse work, including the preparation of soil, potting, repotting, and pricking out plants, and will later be instructed in budding, spading, etc. Each city school is given six free scholarships. First-year pupils not receiving scholarships are charged \$5 tuition. In close proximity to the children's gardens the school of horticulture maintains demonstration plats 40 feet square of many staple crops, such as the cereals, flax, hemp, cotton, sugar cane, rice, tobacco, millet, and sweet and medicinal herbs; also smaller plats of the various budding plants. All of these plats are distinctly labeled, a feature which adds greatly to their educational value.

In Maine, Bath and perhaps a few other cities have begun school-garden work and this last spring the Maine State Pomological Society held a two-day horticultural school for children at Winthrop, in which considerable effort was made to arouse an interest in nature-study work and school gardening. A member of your committee gave an illustrated lecture on school gardens the first evening of the school.

In Providence, R. I., school-garden work began eleven years ago at the Vineyard Street Grammar School with the planting of ferns and violets in one of the angles of the building. Gardens have also been conducted in connection with the kindergarten, the Benefit Street Primary School, and the vacation schools of the last three years. This spring ten new school gardens have been started in the city. At several other points in Rhode Island great interest has been aroused in the work, and at East Greenwich arrangements have been made for beginning in a small way this feature of industrial work. For two years the Rhode Island Horticultural Society has offered prizes for the best-kept school gardens.

In Vermont the State Normal School at Johnson maintains a half-acre experimental school garden in connection with the training school. A portion of the garden is devoted to cooperative flower and vegetable growing by the pupils in the lower grades, the remainder to a potato crop in charge of grammar-grade pupils, each of whom has "one long row to hoe." (Pl. XXXIII, fig. 1.) The work includes instruction

on the use and effect of fertilizers. The Experiment Station at Burlington cooperates with the normal school, furnishing "some of the materials and much good advice." In Burlington a garden was started this spring in connection with the Adams School.

In the State of New York more attention is being given to the improvement of school grounds than to the cultivation of vegetables. In New York City, however, two experiments in vegetable growing by children are worthy of mention. The first of these is at De Witt Clinton Park (Pl. XXXIII, fig. 2), where Mrs. Henry Parsons, a member of the school board, secured permission last year to fence an area 114 by 84 feet for the purpose of giving some of the children in the vicinity useful and wholesome employment. The planting was not done until July, and the soil was very poor, the plow "having turned up rags, wire, lime, and stones," relics of a former dumping ground; but in spite of these drawbacks marked success attended the experiment. A tent was put up, which contained blackboards for instruction and seats for comfort, and later a flag pole was raised. The children came in squads of 25 each, wearing a tag numbered to correspond with the number of his 3 by 6 foot garden, and were given work not only in gardening but also in clearing ground of stones and in preparing it for planting. At first the children were given the choice of being farmers or policemen, and quite a good many thought they would like to be policemen, but after the third day the police force had all deserted to the farm. The work will be continued this year, and there are plans for laying out a country home, including a portable house, lawn, paths, flowers, etc. In a recent letter to the writer, Mrs. Parsons says that the children "work like Trojans and the gangs turn in to help. My little teacher is as safe in that tough neighborhood now as in her own parlor." To overcome in a measure the influence of the street and the factory on graduates of the public schools, Mrs. Parsons has recently organized an alumni association in what is considered the toughest school in that section. The president and vice-president of the association are principals of large schools and are native-born residents of this district.

The other enterprise is in its infancy. Teachers' College has purchased the land lying between Broadway, Amsterdam avenue, One hundred and twentieth, and One hundred and twenty-first streets, about one acre of which will be utilized for educational purposes. A part of this land has already been developed as a school garden or outdoor laboratory for the reorganized and enlarged department of nature study. The garden is both horticultural and agricultural. Cereals have been planted and experimented with, also vegetables and other plants, the whole serving not only as a practice ground for the prospective teacher of a rural school, but also as an object lesson to the

children of the allied preparatory schools, the Horace Mann and the James Speyers experimental schools.

In a few other cities of the North Atlantic States vegetable gardening is being attempted in connection with the schools. Such work has been reported at Elmira, N. Y., and at Trenton, Newark, and Princeton, N. J.

SOUTH ATLANTIC STATES.

In the whole stretch of coast States from Delaware Bay to the Gulf only two school-garden centers are reported. These are at Hampton, Va., and Washington, D. C. At Hampton school gardens are conducted at the Whittier School in connection with the Hampton Normal and Agricultural Institute for Negroes and Indians. Two hundred plats, varying in size from 4 by 6 feet to 11 by 15 feet, are devoted to this work. (Pl. XXXIV.) Each plat is worked by two pupils, and all of the work is done under the supervision of a man who is employed to take general charge of the gardens, plant the border beds, and keep the paths in order. Every child in the school, from the kindergarten to the seventh grade, is required to work in the gardens two recitation periods a week. (Pl. XXXV, fig. 1.) When this work began nearly three years ago, not a few of the pupils thought it a disgrace to work out of doors, but at the present time there is not a pupil in the school who does not look forward with eagerness to the gardening periods. The work is conducted on pedagogical principles, and is so correlated with the other school exercises as to make it truly educational. It is also arranged in such a way that pupils finishing at the Whittier School are fully prepared to take up the agricultural work in the institute. Many of the negro schools in the vicinity of Hampton and Norfolk have begun school-garden work under the direction of Hampton graduates.

Instruction to the school children of Washington in growing flowers and vegetables began in the normal school about a year and a half ago through the cooperation of the Department of Agriculture and the instructor in botany in the normal school. The first year nothing was attempted except home gardening on the part of the normal school students; but this experiment was so successful that plans were made for broadening the work. Last winter the Department turned over to the use of the instructor in botany and her normal school students a small greenhouse and a workroom, where the students met once a week and received instruction as well as practical experience in examining and handling soils, germinating seeds, planting, potting, transplanting, making cuttings, and grafting. When spring came each of the 97 normal school students was required to start a home garden in which she might be able to carry out the instruction and experience of the class room and workroom. Connected with the normal school are

12 practice schools, containing about 450 children, who have been given seeds for home planting and are under the instruction of the normal students. In this way the children are receiving valuable instruction in plant growth and the future teachers of Washington are being trained to carry on the work in an intelligent and practical way.

In addition to this work the Department of Agriculture has placed at the disposal of the normal school a strip of land 10 by 250 feet, which is being cultivated by a class of 30 boys and girls from a sixth-grade school in the vicinity of the Department grounds. (Pl. XXXV, fig. 2.) Each plat is 7 by 10 feet and contains the common garden vegetables and a few flowers. The success of the experiment has been remarkable, not only in the general good condition of the gardens (Pl. XXXV, fig. 3), but in the marked enthusiasm shown by the children for their work. It is all volunteer work, and yet many of the pupils spend time during recess periods and after school at work in their gardens.

The influence of this work in connection with the normal school is extending to other quarters of the city. Through the cooperation of the Department of Agriculture, the National Plant, Flower, and Fruit Guild, and the social settlements in the city, gardens containing from 10 to 35 plats each have been started in several different localities. The places were selected by an officer of the guild, the children to carry on the work were secured through the social settlements, and seed was furnished by the Department, which also sent out a gardener to superintend the planting and now furnishes volunteers to oversee the work. Through these influences also a great many home gardens have been or are being planted in the vicinity of the various garden centers.

SOUTH CENTRAL STATES.

In the South Central States school-garden work has been reported at Louisville, Ky., and Tuskegee, Ala., but no information has reached your committee regarding the status of the work in Louisville this year. At Tuskegee the work is conducted in a practice school connected with the Tuskegee Normal and Industrial Institute much in the same way that gardening is carried on at Hampton. It furnishes practice work for the normal students and prepares pupils in the practice school for entering the institute.

In this connection an enterprise now under way in Tennessee is worthy of mention. Plans have been made and land purchased for the establishment of a central rural school 12 miles from Knoxville. The property acquired contains 14 acres, a part of which will be used for campus, 5 acres for a model farm, and 6 acres for garden, orchard, and playgrounds. The pupils in this school, in addition to receiving a sound elementary education, will learn how to farm, how to plant and cultivate fruits and flowers, and how to raise poultry and operate dairies.



FIG. 1.—AGRICULTURAL EDUCATION—WHITTIER SCHOOL GARDEN, HAMPTON, VA.
KINDERGARTEN CHILDREN.



FIG. 2.—AGRICULTURAL EDUCATION—SCHOOL GARDENS ON GROUNDS OF U. S.
DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.



FIG. 3.—AGRICULTURAL EDUCATION—BEDS KEPT FREE FROM WEEDS AND "WATERED
WITH A RAKE" (STIRRED TO CONSERVE MOISTURE).



FIG. 1.—AGRICULTURAL EDUCATION—A COUNTRY SCHOOL GARDEN, DISTRICT 58,
WINNEBAGO COUNTY, ILL.



FIG. 2.—AGRICULTURAL EDUCATION—DEPARTMENT OF AGRICULTURE OF THE UNIVERSITY
OF MINNESOTA, EXPERIMENTAL SCHOOL GARDEN.

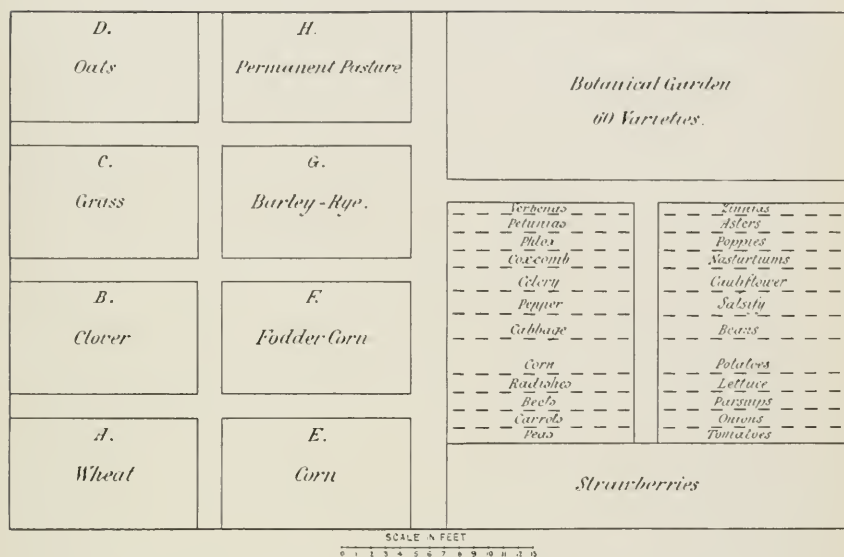


FIG. 1.—AGRICULTURAL EDUCATION—PLAN OF HORACE MANN SCHOOL GARDEN,
MINNEAPOLIS.

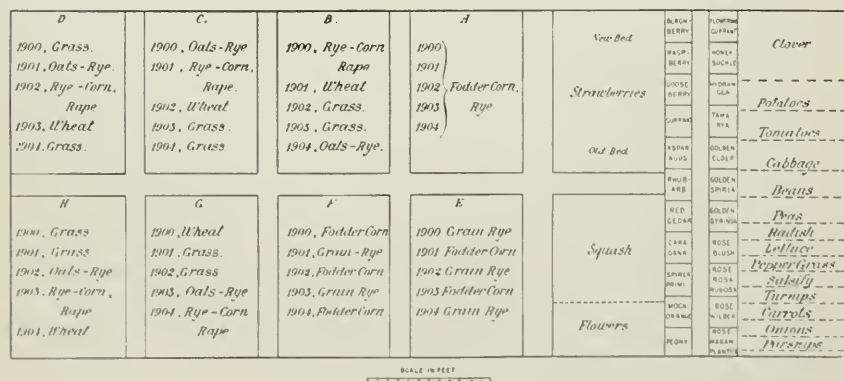


FIG. 2.—AGRICULTURAL EDUCATION—PLAN OF EXPERIMENTAL SCHOOL GARDEN, SHOWING ROTATIONS TESTED BY THE DEPARTMENT OF AGRICULTURE OF THE UNIVERSITY OF MINNESOTA.

NORTH CENTRAL STATES.

In the North Central States the school garden movement is in a condition of ferment. With the exception of a few centers not much has been done yet, but a great deal is being planned.

In Ohio the work of the Home Gardening Association at Cleveland in maintaining school gardens at the Rockwell School and in promoting the home gardening movement throughout the city is being continued. So, too, is the work of the National Cash Register Company at Dayton in furnishing gardens and instruction in gardening for about 70 boys. There is also a movement throughout the State to interest children of the rural districts in growing vegetables and flowers at home. This work is being conducted through the teachers and school officers, encouraged largely by the Ohio Students' Union, the College of Agriculture of the Ohio State University, and the Ohio State Experiment Station. This year 77 boys and 4 girls in Springfield Township are making simple experiments in growing corn, and 18 girls are raising vegetables from seed furnished by the United States Department of Agriculture.

Illinois has several strong agencies working for the introduction of school gardening and instruction in the elements of agriculture among the schools of both city and country. The State superintendent of public instruction, the officers of the college of agriculture of the University of Illinois, the officers of several of the State normal schools, and a number of the county superintendents of schools are active in the movement. There are definite reports of school-garden work being started at the normal schools at Charleston, Normal, Carbondale, and Dekalb, but in the Chicago Normal School nothing of the kind has yet been attempted. The superintendent of schools in Winnebago County, O. J. Kern, of Rockford, is an enthusiastic worker for everything that will improve the rural schools—school gardens, experiments in growing crops by farm boys, the planting of school grounds, and discussions in meetings of teachers. Through his influence school gardens have been started in about 15 districts of the county (Pl. XXXVI, fig. 1), and in many other places flower beds or plants or trees have been set out. This spring every township in Winnebago County had a graduation exercise with a programme full of subjects relating to the beautifying of school premises. The sole topic of the country-school section of the Northern Illinois Teachers' Association, held at Dekalb April 23–25, 1903, was school gardens. It was also an important topic at the Winnebago County Teachers' Institute, held the last two days in April and the first three days in May.

Through the efforts of the Commercial Club, of Indianapolis, Ind., five of the schools of that city were supplied with seeds this year, and garden work was begun.

In Michigan school gardens were started this spring at the Second Avenue School in Grand Rapids, a garden for each room.

In Minnesota, Minneapolis had gardens at the Horace Mann School (Pl. XXXVII, fig. 1) and one or two others last year, and started work at ten schools this spring. Duluth has school gardens at the Webster School. The department of agriculture at the University of Minnesota is doing all that it can for the rational development of school-garden work and other features of elementary agriculture in the schools of the State. Among other things it is conducting experimental school gardens and preparing plans for rural school gardens (Pl. XXXVII, fig. 2).

Omaha is the only city in Nebraska reporting school-garden work. For two years all of the pupils in the lower grades have received instruction in growing plants either in boxes or out of doors, and a number of the schools in the city have engaged quite largely in garden work. Reports indicate that the work has been popular and successful.

In Missouri school gardens are reported at Carthage, Old Orchard, and St. Louis. The work at Old Orchard was started this year, and that at Carthage several years ago by W. J. Stevens, who has since been called to one of the large schools in St. Louis and has inaugurated similar work there. At first Mr. Stevens's work, both at Carthage and St. Louis, consisted in getting the boys started in growing vegetables and flowers at home, but this year he has secured the cooperation of the officers of the Hodgen School, of which he is principal,^a in organizing garden work in connection with the school.

About the middle of June a junior school of horticulture was begun in St. Louis under the direction of the Civic Improvement League. The league was given the privilege of using as much land as was needed of a 160-acre tract belonging to the Missouri Botanical Garden. At present (July 7) 60 gardens, 11 by 165 feet, are laid out and occupied. Any boy in the city may have a similar plot on application free of charge. The common vegetables, such as corn, tomatoes, beans, turnips, etc., and several varieties of flowers are planted, and the planting is uniform throughout the garden. The boys come in classes of 15 one morning each week to receive instruction, and all are present on Saturday morning. There is a wonderful opportunity for work of this kind to succeed in St. Louis, for many citizens have taken a keen interest in the movement. Funds have been provided for expenses and prizes, and enough land has been offered for the use of the gardens next year to enable the league to supply 1,000 boys with gardens if there should be a demand for so much. The boys themselves are most enthusiastic, and there is no doubt that they will be on hand early next spring to put in their claim for gardens.

^a Since promoted to the principalship of the Eugene Field School.

In this connection it is worthy of note that the United States Department of Agriculture has made plans for laying out and conducting model school gardens at the Louisiana Purchase Exposition. Prof. C. F. Wheeler, of the Bureau of Plant Industry, has been put in charge of this work, and if his present plans are carried out an experienced man will be in charge of the gardens throughout the season and will conduct daily exercises with volunteer pupils from the St. Louis schools.

WESTERN STATES.

The far West has furnished your committee but few reports of vegetable gardening in schools. It is known that the normal schools at Los Angeles, Cal., and Salt Lake City, Utah, have made garden work a feature of their practice schools for a number of years. Pueblo, Col., schools have also made successful experiments in gardening. In Riverside County, Cal., school gardening was started this spring in 11 schools. Regarding the work in the Riverside (city) schools, the Riverside Morning Enterprise says "School-garden work was begun by the first and second grades, but the infection soon spread to the third and fourth grades and on to all the other classes of the school. The children spaded up the hard ground themselves, worked it up by rakes and shovels, got all the seeds they could from every source, and took vast pleasure and satisfaction in planting their flowers and vegetables, and in caring for them when they came up. They would fight for the gardens—no one dared lay a finger on them, save in the way of kindness."

INSULAR POSSESSIONS.

Attention has been given to garden work in the schools of Hawaii for more than 50 years. General Armstrong, founder of Hampton Normal and Agricultural Institute, reports that in 1856 he had organized agricultural and industrial societies among the natives and that kale, sweet potatoes, squash, and the like were grown with great success by some of the schools. Work of this kind has been continued up to the present time and now occupies a prominent place in the school curriculum. The work along agricultural lines was found to be so popular and so helpful to the general school work that in 1898, shortly after the establishment of the normal school in Honolulu, a department of nature study and agriculture was organized in this school and put in charge of a graduate of Cornell University. This course in the normal school includes garden and field work, budding, grafting, potting, transplanting, etc., study of domestic and wild animals, beneficial and injurious insects, etc. Plots of ground are assigned to groups of normal students who supervise the work of the pupils of the training school in caring for these plots. These training-school pupils work together by grades, raising vegetables which are disposed

of in the city markets. The proceeds are used to purchase school equipment. The other grade schools of the city are also given instruction similar to that in the training school by a traveling instructor, and a portion of each school ground is set apart for the growing of vegetables.

In the schools of the island outside of Honolulu considerable attention is given to the study of agriculture. In some cases the teachers have special training in this work and the results have been proportionate. Each year the number of trained teachers is being increased by the graduates of the normal school, and the superintendent of public instruction expresses the hope that "in time all the teachers on the force will be fitted to give instruction in the courses of nature study and agriculture."

In Porto Rico 20 agricultural schools, accommodating 50 pupils each, were organized by the commissioner of education in the fall of 1901. Each school was provided one acre of ground where each child was given a small plat on which he was required to work daily. The children were from 6 to 15 years of age and their teachers trained American agriculturists.

EDUCATIONAL WORK OF THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

At the convention of the association held in Washington, D. C., November 17-19, 1903, there was much discussion of educational topics. In the section on horticulture and botany several papers dealt with the teaching of botany and horticulture in the agricultural courses of the colleges. The committee of this section on courses in botany presented an outline of an elementary course in botany together with suggestions as to more advanced courses. This committee was continued, and was directed to formulate its courses with reference to cognate courses on economic lines. The appointment of a committee to act in conjunction with this committee and to report on courses of study in horticulture was also authorized.

In the section on college work the two subjects discussed were the mission of the land-grant colleges and short courses. In the general session the committee on methods of teaching agriculture presented the following report on the relation of the natural sciences to agriculture in a four-year college course:

The more definite formulation of courses of instruction in agriculture, the division of these courses according to the several branches of the science of agriculture, and the consequent specialization of the courses due to the employment of an increased force of experts in various agricultural subjects, have already led to a considerable reorganization of faculties and courses in our agricultural colleges. This movement is continuing and will further develop with the increase of the resources and equipment of the agricultural departments of these institutions. One effect of this move-

ment has been to change the relation of the natural sciences to agriculture in the scheme of instruction in the agricultural colleges. As long as agriculture was taught almost wholly on a practical basis and without much regard to its pedagogical formulation, the teachers of the natural sciences were called upon not only to develop the relations of these sciences to agriculture in their courses of instruction, but to give instruction in strictly agricultural subjects, and this was done to a considerable extent, especially in chemistry and botany. Out of this grew a series of text-books and manuals in which the general principles of these sciences were more or less extensively combined with statements of their relations to the theory and practice of agriculture. Thus we have books on agricultural chemistry, agricultural botany, agricultural physics, etc. The preparation of such books was a very useful work. They helped to turn the attention of scientists to the importance of the problems of agriculture and thus led to the further investigation of these problems; they brought together many facts and principles out of which in large measure the science of agriculture itself is now being constructed. But this method of procedure, as we can now see, had also some unfortunate results from which we are seeking to escape through the more thorough formulation of the science of agriculture and of courses based thereon, and the readjustment of the courses in the natural sciences to meet this new condition of agricultural pedagogy.

One result of the prolonged study of the relations of science to agriculture was to lead both teacher and student too far afield in the pursuit of problems which, though important scientifically, and even economically, had too remote connection with agriculture itself to make it worth while for the student whose aim was to be a master of the theory and practice of agriculture to follow after them. Thus, for example, agricultural chemistry developed a system of analysis of fertilizers, feeding stuffs, and adulterated products which in the minds of many teachers came to be so prominent a part of this branch of chemistry that it often assumed an undue importance in the general agricultural courses in our colleges. Now, we shall always need expert analysts of fertilizers and feeding stuffs, and special courses for the training of those experts should be offered in our agricultural colleges. But these should be clearly differentiated from the courses intended to lay the foundations for the scientific study of agriculture. Under the old system the emphasis was often laid so much on analytical work that the colleges produced many analysts and but few agricultural experts. So in botany it is easily possible, for example, to lay so much stress on studies of fungi and bacteria, or grasses, that the students are led to strive to become experts in vegetable pathology or agrostology. It is true we need many more such experts, but, nevertheless, it should not be the object of botanical studies underlying the general course in agriculture to aim at the training of pathological experts, or agrostologists, or any other kind of botanical experts. While botanical experts and agricultural experts may for a time profitably study botany together their paths should soon diverge, and this must be kept in mind by teachers of botany.

Another unfortunate result of the old arrangement of courses in our agricultural colleges was that the study of the general principles and outlines of the various natural sciences was often unwisely abridged, in order to give more attention to their economic applications. This has perhaps not been so much the fault of the science teachers as of the managers of the agricultural colleges. The attempt to create a very practical atmosphere in these institutions has often led to great disregard of established pedagogical principles in the teaching of the complex subjects relating to agriculture and other arts. Nothing is more firmly established in pedagogical science than the principle that, before proceeding to the study of complex problems, the pupil should become acquainted with the elementary facts and principles involved in the solution of these problems. It is also very generally agreed that an outline study of a general subject which will enable the pupil to have some compre-

hension of the subject as a whole and the relations of its different parts should precede detailed study of special topics included in this general subject. Thus it is best both practically and pedagogically that the boy in the graded schools should be taught an outline of the history of the United States. He will thus acquire a certain amount of information which will be useful to him if he goes out into life from the graded school, and he will also have laid the best foundation for such special studies of United States history as he may have opportunity to pursue in higher courses of instruction. In like manner in the natural sciences there should be a sufficient period of general study before special topics are taken up, and the abridgment of this preliminary course throws the future course of the student out of pedagogical balance.

The general readjustments of science teaching which are demanded by the present development of our agricultural colleges are, therefore, first, the more thorough teaching of the foundations of the natural sciences; secondly, the clearer differentiation of the courses in natural science associated with the courses in agriculture from those which are intended for the training of experts in various economic specialties related to agriculture; and, thirdly, the separation from the science courses of those subjects which may be more appropriately taught by the instructors in the various branches of agriculture itself. From the nature of the case it is obvious that the details of these readjustments can be worked out only as the result of many experimental efforts and long discussion of the practical and pedagogical points involved. The evolutionary forces which are to result in the elaboration of more perfect and satisfactory courses of instruction in agriculture are already at work in our agricultural institutions and they will continue to work for an indefinite period. It has seemed, however, to your committee that at this juncture it would be helpful to call attention to some of the general factors of this evolution and even to suggest a somewhat definite mode of procedure to secure the sought-for ends. In this, as in other lines of its work, the committee has assumed that it would be more useful to present a definite scheme rather than general suggestions. This is done with the understanding, as heretofore, that the committee is not seeking to establish dogmas or write prescriptions, but only to furnish a definite basis for discussion. It is the more encouraged to continue efforts in this line because it is convinced that, as the result of its previous efforts, the movement for the betterment of courses of instruction in our agricultural colleges has been materially aided, though no institution has adopted in detail the programme laid down in the reports of this committee.

As the basis of our presentation of a scheme of science teaching for a four-year college course in agriculture, we take (1) the standard entrance requirements laid down in the report of your committee on entrance requirements as published in Bulletin No. 41 of the Office of Experiment Stations; (2) the general outline of the college course as made by that committee and our committee and published in Circular No. 37 of the Office of Experiment Stations; and (3) the syllabi of courses in the different branches of agriculture as laid down in the reports of this committee published in Circulars Nos. 39, 41, and 45 of said Office.

The standard entrance requirement scheme has been taken, rather than the abridged scheme presented by the entrance requirement committee, because in our judgment there can be no satisfactory arrangement of college courses in agriculture until the students admitted to the college courses have had suitable preparation in secondary schools. Within the past few years there has been a wonderful development of the high schools in all parts of our country and there has been set on foot a movement for the establishment of secondary schools and courses especially adapted to the requirements of our agricultural communities. The agricultural colleges should encourage this development of secondary education in many ways. But they should do so especially by differentiating their college courses more distinctly from secondary courses, and putting their college courses on a sufficiently high basis

to make the bachelor's degree from an agricultural college represent an education of as high a grade as a bachelor's degree from any other college. For this purpose the standard entrance requirement scheme referred to above is none too high. This provides for at least a year's instruction in some natural science. It is believed by your committee that ordinarily an elementary course in physics or chemistry in the high school will best lay the foundation for further science study. In the scheme herewith presented we selected physics as the science to be taught in the high school as the preliminary to science study in the college course in agriculture.

In the general scheme of the four-year college course in agriculture presented herewith, we have first provided for courses in general physics and chemistry on the assumption that these would naturally precede the study of plants and animals, whether in a general way under the head of botany, physiology, or zoology, or in a special way under the different branches of agriculture. Some knowledge of physics and chemistry is also essential to a proper understanding of even the elements of meteorology and geology, as provided for in this course. Botany has been so placed as to run along with agronomy, and physiology and zoology with the more scientific presentation of zootechny.

While we believe it would be well for the agricultural student in his undergraduate work to take all of the subjects included in the scheme as here outlined, yet we have recognized the demand for an earlier specialization of agricultural work by so arranging the course that in senior year at least some studies may be substituted for those laid down in our scheme. For example, if the student is aiming to be a plant expert he may omit veterinary science and take more of applied botany or horticulture, or specialize in agronomy as far as additional courses in these subjects are offered in the institution he attends. In a similar way the student devoted to animal industry may substitute special studies along this line for the horticulture and forestry.

Agricultural experts can not, however, expect that any properly adjusted undergraduate course will fully meet their needs for training along their chosen lines. Persons who expect to enter positions in our Department of Agriculture, experiment stations, or agricultural colleges should attain at least the master's degree. And ere long the doctor's degree will be a prerequisite to entrance on the career of agricultural teacher or investigator in our colleges and universities and the National Department of Agriculture.

In outlining the courses in the various sciences the purpose has been to indicate in a general way the topics which may properly be included in such courses, taking into account the time limitations and what will be taught under the head of agriculture. The arrangement of these topics and the emphasis to be laid on each of them will, of course, vary with the teacher as well as the equipment and other conditions existing in particular institutions. Our effort has been chiefly to so present this matter as to indicate how the science teaching may be differentiated from and at the same time related to the teaching of agriculture in a college course.

In arranging this scheme the committee has had the assistance of the expert officers of the Office of Experiment Stations and of Prof. G. P. Merrill, the geologist of the Smithsonian Institution. Text-books and specialists in a number of different lines have also been consulted. As the result of a conference with Mr. A. F. Woods, assistant chief of the Bureau of Plant Industry, who is chairman of a committee appointed by the section of botany and horticulture of this association to formulate a scheme for courses in botany, it was ascertained that, after an independent study of this matter, that committee had reached substantially the same conclusions as had our committee, as far as the lines of our work coincided, and that both committees were in general accord with the scheme proposed by a committee of the Society for Plant Morphology and Physiology. Special attention is therefore invited to the report presented by Mr. Woods to the section on botany and horticulture.

The standard series of entrance requirements referred to above is as follows:

- (1) Physical geography.
- (2) United States history.
- (3) Arithmetic, including the metric system.
- (4) Algebra, to quadratics.
- (5) English grammar and composition, together with the English requirements of the New England Association of Colleges and Preparatory Schools.
- (6) Plane geometry.
- (7) One foreign language.
- (8) One of the natural sciences.
- (9) Ancient, general, or English history.

The general relation of the natural-science courses to those in agriculture and other subjects may be seen in the following outline of the agricultural course in college as laid down in a previous report of this committee:

Agricultural course in college.^a

Freshmen.		Sophomores.		Juniors.		Seniors.	
Subjects.	Hours.	Subjects.	Hours.	Subjects.	Hours.	Subjects.	Hours.
Physics.....	150	Agriculture:		Agriculture:		Agriculture:	
Chemistry.....	150	Zootechny 60	150	Agronomy 50	150	Dairying 70	190
Geometry and trigonometry.	155	Agronomy 90		Zootechny 100		Farm mechanics 60	
English.....	120	Meteorology.....	60			Rural economics 60	
Modern language.....	180	Agricultural chemistry.....	180	Geology.....	120	Veterinary medicine.....	180
		Botany.....	120	Botany.....	60	Horticulture and forestry..	180
		English.....	80	Physiology.....	180	History and political economy.....	190
		Modern language.....	100	Zoology.....	120	Ethics.....	40
		Drawing.....	60	Psychology.....	60		
				Modern language.....	60		
	755		750		750		780

^a A general outline of this course, without reference to its division according to years, was given in the second report of this committee. (See U. S. Dept. Agr., Office of Experiment Stations Bul. 49 and Circ. 37.) The number of hours assigned to each subject includes the time given to laboratory exercises, each of which would occupy two hours. Thus, for example, 150 hours of physics may be divided into 60 lectures or recitations, and 45 (= 90 hours) laboratory exercises. Our committee has not attempted to say how the time should be divided between lectures or recitations and laboratory exercises, but presupposes that a reasonable number of laboratory exercises or practicums will be given in all the science courses.

The arrangement of the college course here suggested proceeds on the assumption that it is best for the student to devote his time largely during the first two years to language, mathematics, and the fundamental sciences, physics, chemistry, and botany. He will thus be prepared for a better understanding of the more complex sciences of agriculture, zoology, animal physiology, and veterinary medicine in the second half of his course.

The course in agriculture has been arranged with reference to taking up first in sophomore year some of the simpler topics in zootechny, such as stock judging and types of breeds, which do not require scientific knowledge, but are well calculated to arouse the interest of the student in agricultural subjects. Agronomy may then be taken up systematically and run along with the study of meteorology, agricultural chemistry and botany, and the more scientific study of zootechny may be parallel with the study of physiology and zoology. In senior year a considerable number of electives could be offered, one or more of which might be substituted for veterinary medicine, horticulture and forestry, or history and political economy, so as to enable the student to specialize in agronomy, horticulture, zootechny, dairying, farm me-

chanics, vegetable pathology, entomology, etc. In general, however, it is believed that the course as here outlined will be satisfactory as providing a liberal education, including systematic study of the theory and practice of agriculture, and as a good foundation for specialization in agriculture and the sciences related thereto in post-graduate courses.

COURSES IN THE NATURAL SCIENCES.

PHYSICS—PREPARATORY COURSE.

General laws and principles of—
Dynamics of solids, liquids, and gases,
Heat,
Electricity and magnetism,
Sound,
Light.

PHYSICS—COLLEGE COURSE—150 HOURS.

GENERAL CONSTITUTION AND PROPERTIES OF MATTER.

DYNAMICS OR THE GENERAL
LAWS OF FORCE AND THE
RELATIONS EXISTING BE-
TWEEN FORCE, MASS, AND
VELOCITY AS APPLIED TO

(Solids (mechanics).
Liquids (hydrostatics).
Gases (pneumatics).
Measurement of temperature (thermometry).
Expansion (solids, liquids, gases).
Measurement of quantity of heat (calorimetry, specific
heat).
Latent heat.
Fusion and solidification.
Evaporation and condensation.
Conduction.
Radiation.
Thermodynamics.
Relation of temperature to movements of the atmosphere.

HEAT -----

ELECTRICITY AND MAGNET-
ISM.

(General theories and laws.
Sources and production.
Measurement.
Atmospheric electricity.
Applications.

SOUND AND LIGHT -----

(Sound—production and propagation.
Light ---- { Propagation.
Reflection.
Refraction.
Polarization.
Applications—lenses and optical instruments.
Color.

GENERAL CHEMISTRY—150 HOURS.

PROPERTIES OF ELEMENTS AND CHEMICAL REACTIONS.

INORGANIC PREPARATIONS.

INTRODUCTION TO QUALITATIVE ANALYSIS. { Blowpipe analysis.
Separation of groups.

INTRODUCTION TO ORGANIC CHEMISTRY.

BOTANY I.—GENERAL PRINCIPLES.

ANATOMY AND MORPHOLOGY.	The seed	Types.	
		Structures.	
	The shoot	Homologous parts.	
		Food supply.	
	The shoot	Germination.	
		Gross anatomy.	
	The shoot	Phyllotaxy.	
		Buds	{Common forms.
	The shoot		{Winter forms.
		The shoot	Tissues .....	{Structure.
	The shoot .....			{Distribution.
		The shoot	Specialized forms of stems, leaves, etc.
	The shoot		Growth, annual.
		The shoot	Shedding of bark, leaves, etc.
	The root		Gross anatomy of typical root.
The root		Secondary roots.	
	The root	Specialized forms.	
The root		Tissues	{Structure.
	The root		{Distribution.
The flower		Typical structure.	
	The flower	Function of parts.	
The flower		Morphological study of several parts.	
	The flower	Construction of diagrams	{Transverse.
The flower			{Longitudinal.
	The fruit	Structure with especial reference to changes from flower to fruit.	
The fruit		Morphological study of types.	
	The cell	Contents.	
The cell		Structure.	
	The cell	Modifications.	
The cell		Formation of tissues.	
	PHYSIOLOGY.	Rôle of water	Absorption.
Transfer.			
Rôle of water		Transpiration.	
		Turgidity.	
Rôle of water		Plasmolysis.	
		Photosynthesis	Rôle of chlorophyll.
Rôle of light.			
Photosynthesis		Rôle of carbon dioxide.	
		Evolution of oxygen.	
Photosynthesis		Study of starch grains.	
		Respiration	Rôle of oxygen.
Respiration			Evolution of carbon dioxide.
		Digestion	Action of diastase.
Digestion			Translocation of food.
		Irritability	Nature of stimulus.
Irritability	Nature of response.		
	Irritability	Geotropism.	
Irritability		Heliotropism.	
	Irritability	Hydrotropism, etc.	
Growth		Localization.	
	Growth	Amount of growth in seeds, stems, etc.	
Growth		Relation to temperature, moisture, etc.	
	Reproduction	Fertilization.	
Reproduction		Sexual.	
	Reproduction	Asexual.	

ECOLOGY.—A STUDY OF PLANTS IN THEIR RECIPROCAL RELATIONS.	{	Modifications for special functions. Dissemination. Cross pollination. Light relations.
		Mesophytes. Hydrophytes. Halophytes. Xerophytes. Climbers. Epiphytes. Parasites. Saprophytes. Insectivorous plants. Symbiosis. Plant associations. Zonal distribution.

BOTANY II.—NATURAL HISTORY AND CLASSIFICATION.

CLASSIFICATION.

STRUCTURE.

REPRODUCTION.

HOMOLOGIES.

ADAPTATIONS.

TYPES FOR STUDY.....	{	Algae	Plenrococcus. Spirogyra. Vaucheria. Fucus.
		Fungi	Bacteria. Yeasts. Rnsts. Smuts. Mildews. Toadstools. Puffballs.
	{	Lichens	Parmelia.
	{	Bryophytes	Hepatics (Marchantia or Porella). Mosses.
	{	Pteridophytes ...	Ferns. Horsetails. Lycopodium.
	{	Gymnosperms ...	Pine.
	{	Angiosperms	Monocotyledon. Dicotyledon.

METEOROLOGY—60 HOURS.

The course here outlined assumes some knowledge of general weather changes as illustrated on the daily weather map and as recommended by the conference on geography of the National Educational Association in 1893 for the lower schools, and that the student has taken an elementary course in physics in the high school or first year in college, and especially has precise knowledge of mass, volume, density; force, inertia, velocity, rotation, centrifugal force; gravitation, gravity, weight; atom, molecule; solid, liquid, gas; expansion, heat, temperature, specific heat, latent heat.

DEFINITION AND SCOPE.

THE ATMOSPHERE (IN GENERAL) . . .	{ Origin. Composition. Extent and weight. Arrangement about the earth (relations to geo- sphere and hydrosphere).
TEMPERATURE	{ Sources, nature, transmission of heat. Variations. Measurement. Distribution over the earth.
PRESSURE	{ General principles. Measurement. Distribution. Relations to atmospheric circulation.
CIRCULATION—GENERAL MOVEMENTS AND LOCAL WINDS.	{ Measurement. Distribution. Causes and modifying influence (convectonal theory and effects of earth's rotation). Classification.
ATMOSPHERIC MOISTURE.	{ Origin. Measurement. Distribution. { Condensation in form of { Dew. Frost. Clouds.
STORMS	{ Cyclones { Tropical. Extratropical. Anticyclones. Thunderstorms. Tornadoes.
PRECIPITATION . . .	{ Rainfall { Sources. Measurement. Distribution. Relation to atmospheric circulation. Snow, hail, etc.
WEATHER	{ Of different zones and seasons. Observation and prediction.
CLIMATE	{ Of different zones, elevations, and localities. Variations.

GEOLOGY—120 HOURS.

THE EARTH IN ITS RELATION TO THE SOLAR SYSTEM.

GEOGNOSEY: THE MATERIALS OF THE EARTH.	{		The Atmosphere—composition, volume, and weight.
	{		The Ocean—composition, volume, and weight.
	{	{	The Solid Globe—dimensions, shape, and constitution.
			Elements constituting rocks.
			Minerals constituting rocks.
DYNAMICAL GEOLOGY.	{	{	Rocks.
			Action of the atmosphere and of heat and cold.
			Chemical action of water.
			Mechanical action of water and ice.
			Action of plants and animals.
STRUCTURAL GEOLOGY.	{	{	The weathering of rocks and formation of soil.
			Weathering of granite, gneiss, trappean rocks, sandstone, limestone, slate, etc.
			Proportional amounts of various constituents removed or lost.
			Physical manifestations of weathering—size and shape of resultant particles, and their chemical composition.
STRATIGRAPHIC GEOLOGY (HISTORICAL GEOLOGY).	{	{	Volcanoes, hot springs, and geysers.
			Earthquakes.
			Upheaval and depression.
			Circulation of water in springs, rivers, and oceans.
			Glaciers and glaciation.
MAN AS A GEOLOGICAL AGENT.	{	{	Erosion and deposition.
			Metamorphism.
			Architecture of the earth's crust, stratification and bedding, jointing, cleavage, mode of occurrence of rock masses.
			General principles.
			Development of life.
ECONOMIC GEOLOGY.	{	{	Development of continents.
			Ore deposits—occurrence and mode of deposition.
			Ores of the metals.
			The nonmetallic minerals.
			Building and decorative material.
PHYSIOGRAPHIC GEOLOGY.	{	{	Road metal.
			Mineral waters, artesian waters, etc. (hydrography).
			Soils—surveys and mapping.
			Physiography—its influence on distribution and development of the human race, etc.

PHYSIOLOGY—180 HOURS.

Physiology is the science of the functions of living tissue (here confined to animals). The main facts and theories of animal physiology apply to man and the various domesticated animals, and constitute the subject of general physiology. If preferred, a course in human physiology covering substantially the same topics, may be substituted. In the agricultural college the hygiene of domesticated animals will ordinarily be taught under the separate subject of zootechny, and the same may be said for metabolism and digestion in different species of animals. Illustrative materials and simple demonstrations will be used in connection with the lectures or text-book.

DEFINITIONS, PROBLEMS, METHODS OF STUDY.

PROTOPLASM -----	{	Composition.	{	Metabolism.
		Functions -----		Change of form.
				Movements.
				Development of energy.
				Irritability.
				Reproduction.

PHYSICAL AND CHEMICAL CONDITIONS OF ANIMAL LIFE.

MECHANICS OF ANIMAL LIFE.

DIGESTION -----	{	Saliva.	
		Gastric juice.	
		Bile.	
		Pancreatic juice.	
		Intestinal juices.	
		Lacteals and lymphatics.	
		Mechanism of digestion.	
BLOOD-----	{	Absorption.	
		Assimilation.	
		Distribution of the products of digestion.	
		Composition and elements.	
		Distribution in the body.	
RESPIRATION -----	{	Respiratory changes in the blood and tissues.	
		Oxygen, carbon dioxid, and nitrogen in the blood.	
		Mechanics of respiratory movements.	
		Nervous control of respiration.	
		Relations of circulatory and respiratory systems.	
EXCRETION-----	{	Composition and excretion of urine.	
		Excretion of sweat and nature and amount of perspiration.	
		Feces.	
CIRCULATION -----	{	Structure of heart, arteries, veins, and capillaries as related to their functions.	
		Course of circulation.	
		Mechanics of circulation.	
		Nervous control.	
		Blood pressure.	
		Pulse.	
		Fluctuations in quantity of blood.	
MUSCULAR ACTION -----	{	Simple muscular contraction.	
		Relation of nervous and muscular systems.	
		Changes in muscles during contraction -----	
		{	Chemical.
			Thermal.
Electrical.			
	{	Conditions which determine muscular irritability and action.	

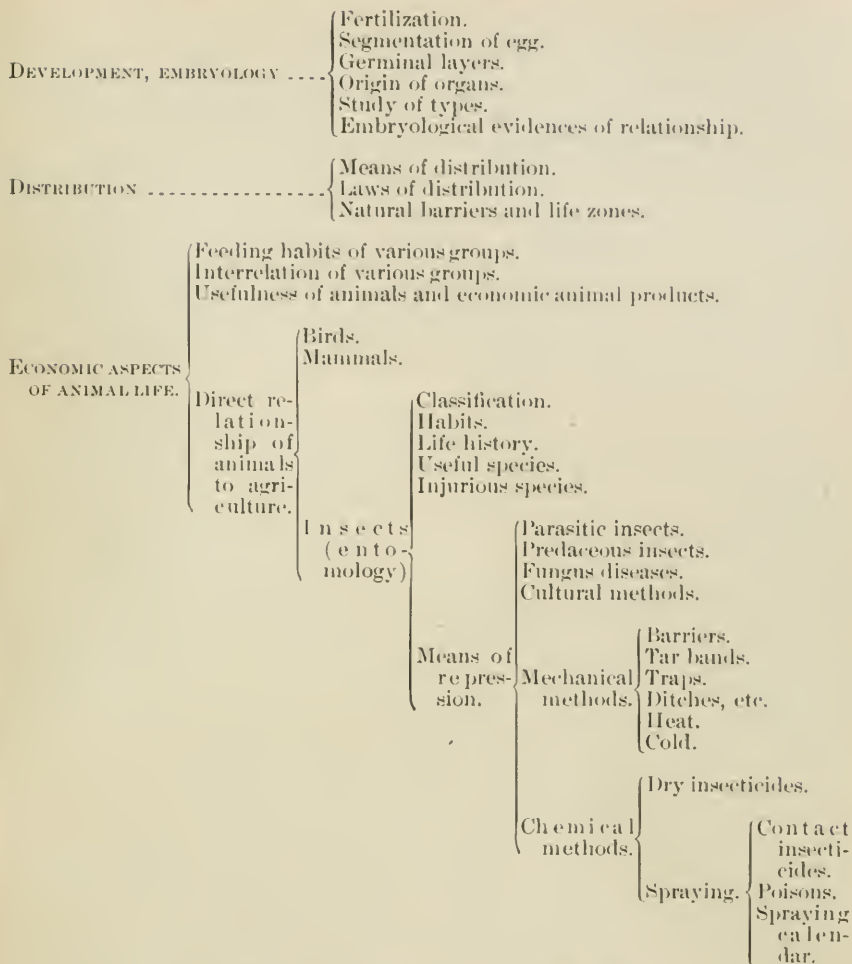
NERVOUS SYSTEM	Brain..	{	Structure and anatomy of brain as related to nervous functions.
			Localization of motor and sensory areas in the brain.
			Conditions of cerebral action.
	Spinal cord..	{	Structure and functions.
			Reflex action.
	Special senses ..	{	Sight.. { Structure and optical principles of the eye.
			Function of various parts of the eye.
			Hearing.. Structure and functions of the ear.
			Smelling.. Structure and functions of the nasal fossae.
			Taste..... { Functions of various organs concerned in this sense.
REPRODUCTION --	{	Function of various organs.	
		Nutrition of the fetus.	
COMPARATIVE PHYSIOLOGY.	{	Comparative study of various functions in animals and man, e. g., digestion in man, horse, cow, sheep, hog, and chicken.	

ZOOLOGY—120 HOURS.

Zoology is the science of animal life in its broadest sense. In agricultural colleges the subject matter of zoological courses is perhaps best largely confined to a study of the anatomy, habits, distribution, and natural enemies of the important injurious and beneficial species. The special economic aspects of domesticated mammals and birds would naturally be taught under zootechny, while the general subject of the interrelations of animals to man comes under the subject of zoology. An outline course in economic entomology is provided in connection with the course in zoology. The course, as a whole, provides for forty to forty-five lectures, and about eighty practieums (of two hours each).

DEFINITION AND GENERAL ORIENTATION.

CLASSIFICATION -----	{	Protozoa.
		Celenterata.
		Echinodermata. }
		Mollusca.
		Vermes.
		Arthropoda.
		Bryozoa.
		Brachiopoda.
		Tunicata.
		Vertebrata -----	{	Fishes.
		Amphibians.
		Reptiles.
		Birds.
		Mammals.
GROSS ANATOMY -----	{	Discussion and study of types of various groups.
		Comparative morphology of organs in various groups.
		Anatomical evidences of relationship and evolution.
MICROSCOPICAL ANATOMY -----	{	Simple cell.
		Muscle cell.
		Gland cell.
		Bone cell.
		Nerve cell.
		Various forms of tissue.



THE AGRICULTURAL COLLEGES.

The States are contributing more liberally than ever before to the support of the agricultural colleges. During the past year special appropriations for the better equipment and maintenance of these institutions aggregating more than \$1,500,000 have been made. This will enable them not only to provide more adequate buildings and facilities, but also to extend their courses of instruction. The extension of their work is along two main lines: (1) To make the courses of college grade more complete by the differentiation of the different branches of agriculture and the addition of courses in rural engineering and rural economy, which subjects have hitherto been largely neglected; and (2) to provide for the broader extension of agricultural education through secondary schools, short courses, summer schools,

normal courses, correspondence courses, farmers' institutes, and other forms of university extension work.

Among the buildings recently completed at the colleges, which will be for the general use of the agricultural departments, are those in South Carolina and Wisconsin.

In South Carolina a building has been erected for the use of the agricultural department of the college and offices of the experiment station at a cost of \$50,000, exclusive of furniture and equipment. The architect's drawing of the South Carolina building is shown in Pl. XXXVIII. The following description of the new building for the College of Agriculture of the University of Wisconsin is taken from the Experiment Station Record:

Agricultural Hall, the new agricultural building of the Wisconsin College of Agriculture, makes provision for the administrative offices of the college and the experiment station, as well as the departments of agronomy, animal husbandry, bacteriology, and chemistry. In it are also located the offices of the superintendent of farmers' institutes.

The structure has a frontage of 200 feet by 64 feet in depth, and is three stories in height over an amply lighted, full-height basement. In the rear is an addition in the form of an octagon (only partly shown in the accompanying plans), two stories in height and 66 feet across. The building is constructed of buff pressed brick, terra cotta, and Indiana buff Bedford limestone. It has a roof of red tile, and all outside metal work, including cornice, is of copper. It is of slow-burning construction throughout.

Heat is supplied by the central heating plant of the agricultural college, the steam pipes being brought from the heating plant to the agricultural building in an ample tunnel. Running under the hallway of the basement is a large tunnel or "plenum," in which one can walk upright without inconvenience. This tunnel has a brick floor, brick sides, and plastered ceiling. Under it runs the sewer pipe. In it run steam, gas, water, and electric-wire pipes, all accessible. From this main tunnel or plenum run branches to vertical air ducts here and there throughout the building. The tunnel system is connected with the fan room. Tempered air is forced by an electric fan into the tunnel, thence into the various branches and upward into the several rooms. Other pipes carry the foul air picked up at the floor out through two large ventilating chimneys in the roof of the building. There are ample steam radiators to warm the building in addition to this indirect system.

The arrangement of the laboratories, lecture rooms, offices, etc., of the various departments accommodated in the building is shown in the accompanying plans. In addition to the usual facilities for these departments, there are five fire-proof vaults, document, museum, and seminary rooms, and an unusual number of closets and storerooms. Space has been reserved for one or two departments not yet organized. The mailing room is located near the east entrance, which has a porte cochere, affording protection from storms in handling mail matter. There is a large room for the storage of extra bulletins and reports; also a room for duplicates from the library.

On the basement floor of the octagon at the rear is located the agricultural library, with accommodations for 20,000 volumes, and a large reading room. On the floor above is an auditorium, a gallery communicating with the second floor. This hall has a seating capacity of over 700 and is unobstructed by posts. The octagon form brings the audience as close as possible to the speaker, both on the main floor and in the gallery.

Plate XXXIX shows the building in a somewhat incomplete condition. When completed there will be a stone railing around the east portico, and an ornate, wide balustrade stairway of cut Bedford stone will furnish the approach up the sloping incline to the front entrance.

For this building the legislature of 1901 appropriated \$150,000. Architect's fees, grading the grounds, and other initial expenses were not covered by this appropriation. The plans were drawn and the construction supervised by Mr. J. T. W. Jennings, the university architect. The legislature of 1903 made a further appropriation of \$25,000 for the necessary furniture and fixtures.

With the completion of this building the agricultural college will occupy a group of four buildings located at the west end of Observatory Hill. These are all devoted strictly to agricultural instruction and experiment station work, the training which agricultural students receive in science, language, mathematics, mechanics, etc., being given in the other departments of the university. The farm barns are located about 60 rods farther west.

A number of laboratory buildings for the use of both college and station have also been constructed, including a two-story judging pavilion for agronomy and animal husbandry, at the Iowa College of Agriculture and the Mechanic Arts (Pl. XLIV, fig. 1); a large new physical-science building at the Kansas Agricultural College (Pl. XLIV, fig. 2), which has recently been completed at a cost of \$57,000; a new science building at the Mississippi Agricultural College (Pl. XLV, fig. 1), which will furnish better quarters for the departments of agriculture, horticulture, and entomology in both college and station, and a new chemistry building for the Nevada college and station (Pl. XLV, fig. 2).

COURSES IN RURAL ENGINEERING.

Within the past few years there has been a rapid increase in the interest manifested by the agricultural colleges in subjects connected with the construction and use of farm machinery and the use of various kinds of power for agricultural purposes. In a number of institutions this has led to the establishment of more definite courses in those topics which are commonly grouped under the name of farm mechanics. There is also a decided tendency to enlarge the courses on subjects relating to irrigation, drainage, water and sewage systems, farm buildings, roads, and related subjects, and thus to prepare the way for the establishment of separate departments of rural engineering. This movement has recently been emphasized by the provision in several of our larger agricultural institutions of special equipment for work in these lines.

At the College of Agriculture of the University of Illinois five courses in subjects connected with rural engineering are given. These courses are thus described in the university catalogue for 1903:

Drainage and irrigation.—Location of drains and irrigation conduits, leveling, digging, laying tile and pipes, filling and subsequent care, cost of construction and efficiency, sewers for the disposal of waste from farm buildings, and the sewage from

kitchen and toilet; farm water pipes, pipe and thread cutting. Class work, laboratory and field practice.

Field machinery.—The tools and machinery of the field, plows, harrows, and hoes; seeders, drills, corn and potato planters, cultivators, weeders, and spraying machines; mowers, rakes, self-binders, corn harvesters and huskers, potato diggers, wagons, etc. Class work and laboratory practice, including setting up and testing machines (Pl. XLVI), noting construction and elements necessary for successful work.

Farm power machinery.—Horsepowers, gas engines, traction engines, windmills, pumps, corn shellers, feed cutters, grinders, and thrashing machines, their construction, efficiency, durability, and care. Class room and laboratory work.

Farm buildings, fences, and roads.—The arrangement, design, construction, and cost of farm buildings, especially of barns, granaries, and silos; the different kinds of fences, their cost, construction, efficiency, and durability; cost and construction of roads and walks. Class work and practice in designing and drafting buildings, operating fence-building machines, setting and testing fence posts, making walks, etc.

Special work in farm mechanics.—Students may arrange for special work in any of the lines covering drainage or farm machinery, either in the second semester or the summer.

Special provision is made for these courses in the large agricultural building of the university, and "the college keeps on deposit from the largest manufacturers several thousand dollars' worth of plows, cultivators, planters, cutters, shellers, grinders, mowers, binders, engines, etc." This work is in charge of F. R. Crane as instructor in farm mechanics.

At the Iowa College of Agriculture and Mechanic Arts a department of farm mechanics has recently been established and a special building erected for its use. The following description of this building is taken from an article in the Experiment Station Record:

The building for the new department of farm mechanics is an addition to Agricultural Hall, and is connected with it by a corridor 27 feet long by 15 feet wide. (Pl. XLVII.) The main part of the new building is 60 by 100 feet and contains two main floors. Each of these floors has a balcony about 12 feet wide, which is supported by steel columns. The second floor balcony extends over only a part of that floor, the remainder being inclosed and constituting an attic or third floor. The effect is, therefore, that of a four-story building, there being windows on each of the main and balcony floors.

The first or ground floor (Pl. XLVIII) contains a large machinery operating room 66½ feet long by the full width of the building, with an approach 14 feet wide and paved with brick. This room will be used for the study and operation of farm motors, such as gas engines, steam traction engines, etc. At one side is a row of double forges supplied with blast from a fan, and a double row of anvils, for students' use, and across the end is a row of benches. On this floor are also located wood-working and iron-working shops for experimental purposes, both well equipped with hand and power machines, and also tool rooms, toilet room, and a supply of lockers. These rooms and the corridor all have a brick floor. The balcony of this floor will be used as a carpenter shop for students of this department, and be provided with circular saws, lathes, grindstone, emery wheel, etc.

On the second floor (Pl. XLIX) are located offices for the head of the department, a class room about 21 by 30 feet, a drafting room 22 by 27 feet, and a students' study and reading room 17 by 22 feet. About half of this floor will be occupied by a

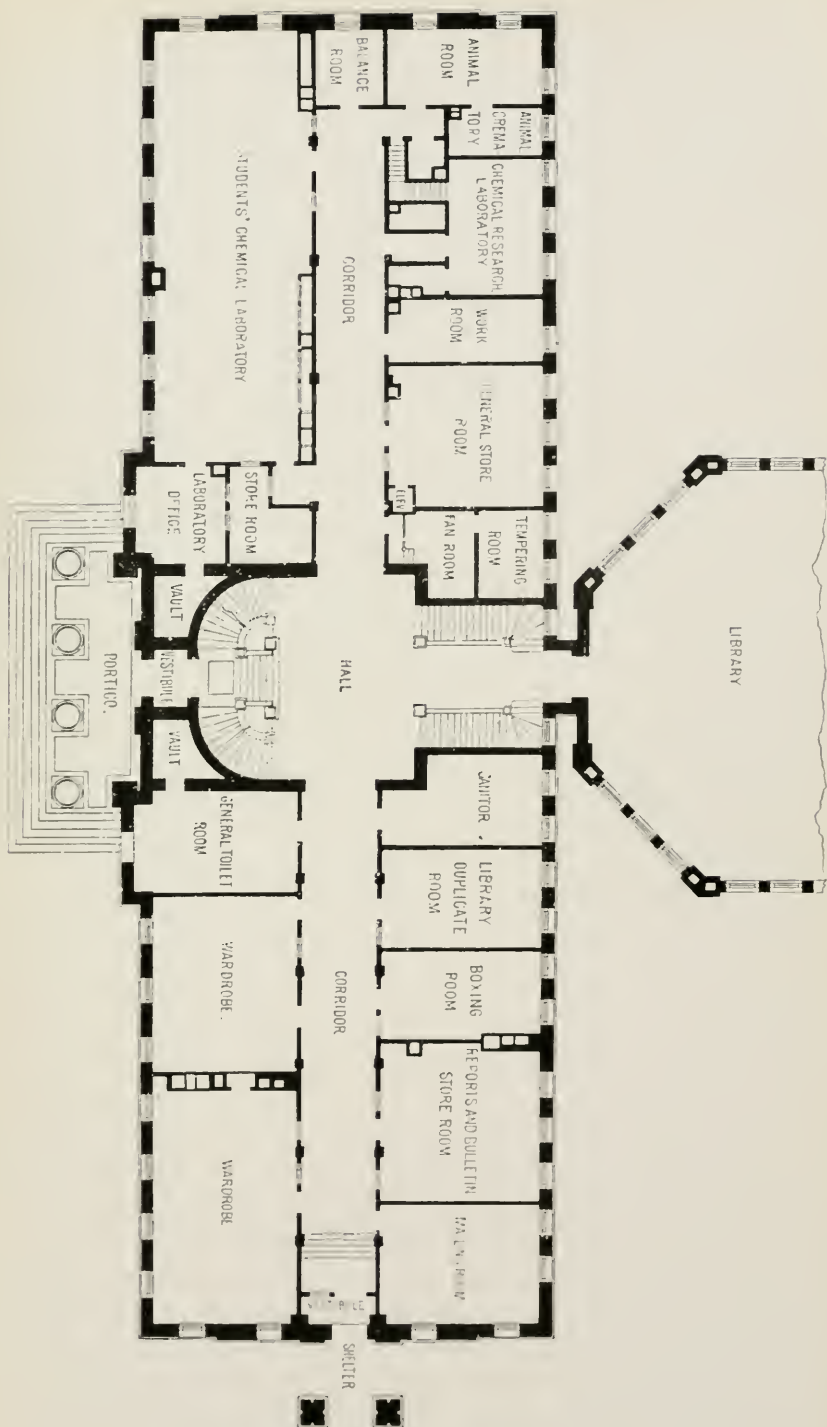


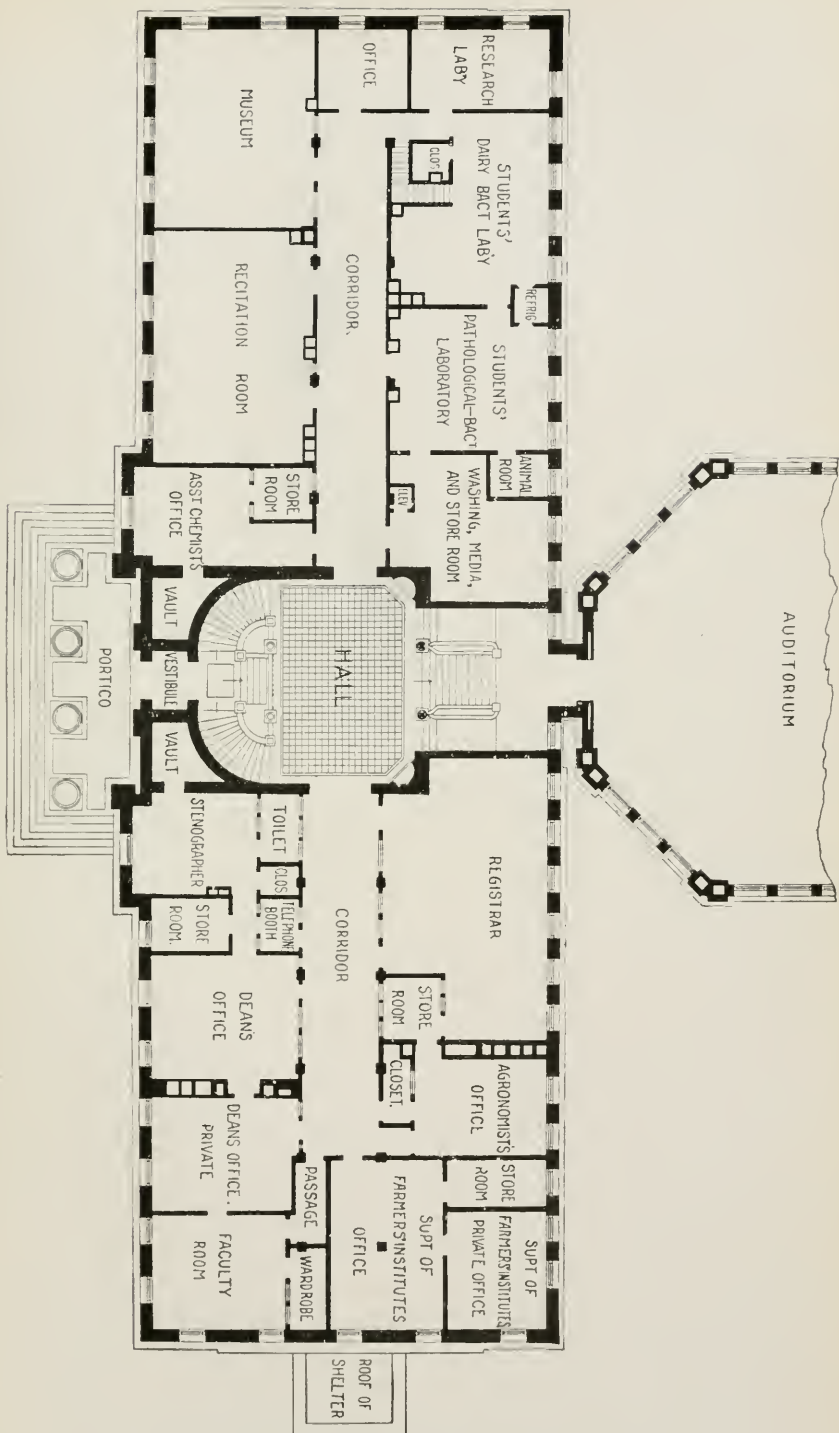
AGRICULTURAL EDUCATION—SOUTH CAROLINA COLLEGE, AGRICULTURAL HALL.



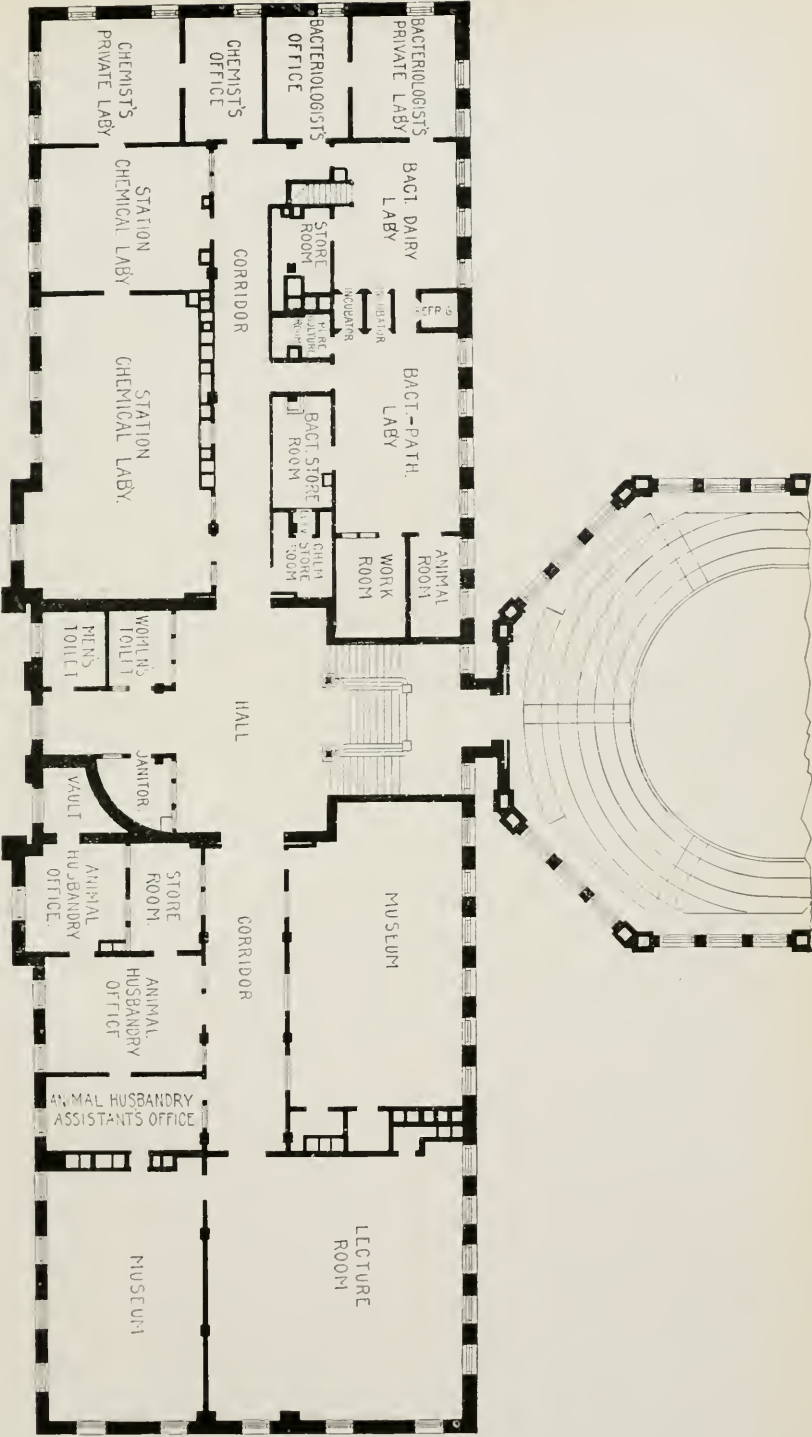
AGRICULTURAL EDUCATION—WISCONSIN UNIVERSITY, AGRICULTURAL BUILDING.

AGRICULTURAL EDUCATION—BASEMENT PLAN OF THE AGRICULTURAL BUILDING, WISCONSIN UNIVERSITY.

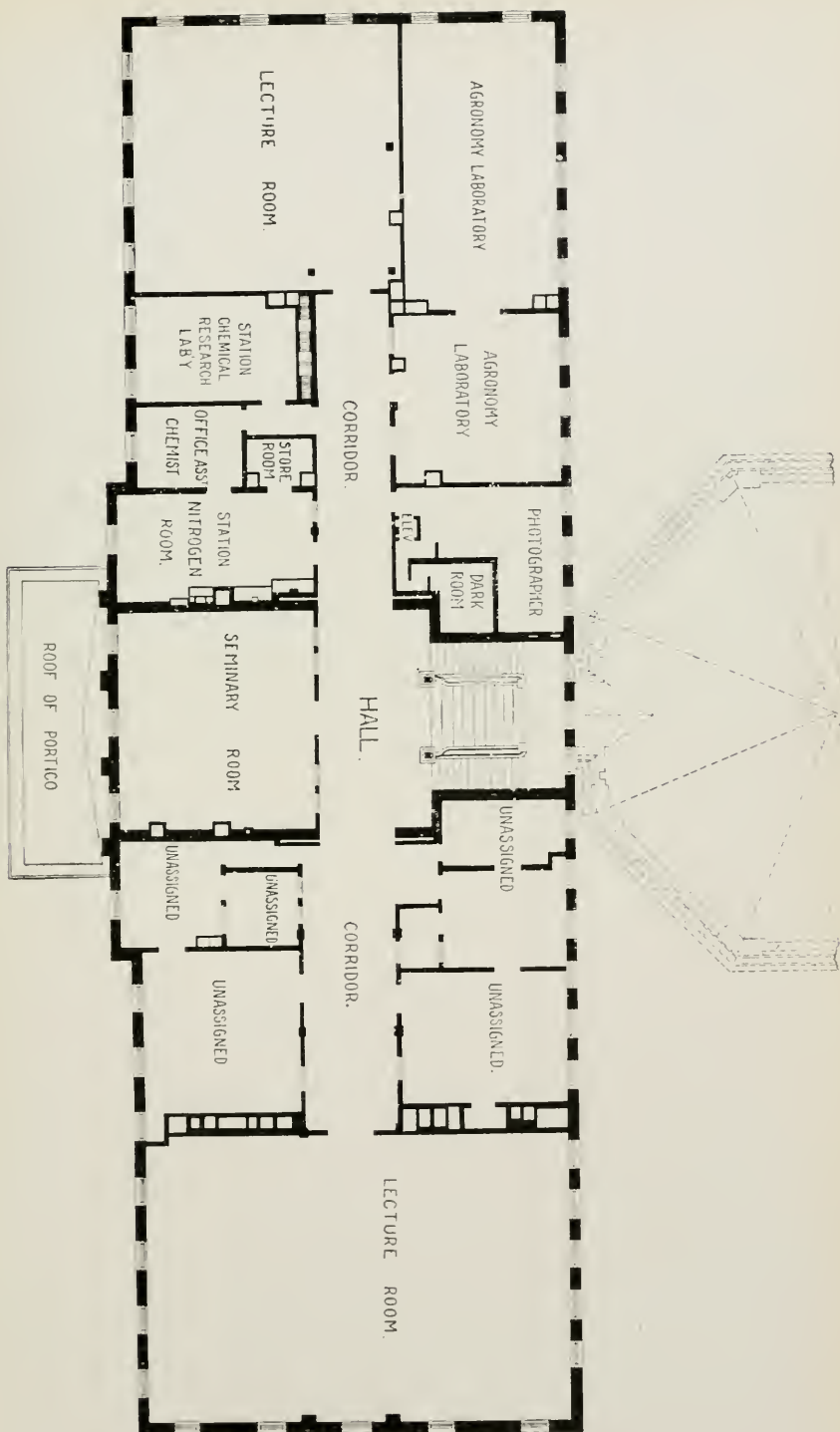




AGRICULTURAL EDUCATION—FIRST-FLOOR PLAN OF THE AGRICULTURAL BUILDING WISCONSIN UNIVERSITY.



AGRICULTURAL EDUCATION—SECOND-FLOOR PLAN OF THE AGRICULTURAL BUILDING, WISCONSIN UNIVERSITY.



AGRICULTURAL EDUCATION—THIRD-FLOOR PLAN OF THE AGRICULTURAL BUILDING, WISCONSIN UNIVERSITY.



FIG. 1.—AGRICULTURAL EDUCATION—IOWA COLLEGE, NEW JUDGING PAVILION.



FIG. 2.—AGRICULTURAL EDUCATION—KANSAS COLLEGE AND STATION, SCIENCE BUILDING.



FIG. 1.—AGRICULTURAL EDUCATION—MISSISSIPPI COLLEGE AND STATION, SCIENCE BUILDING.



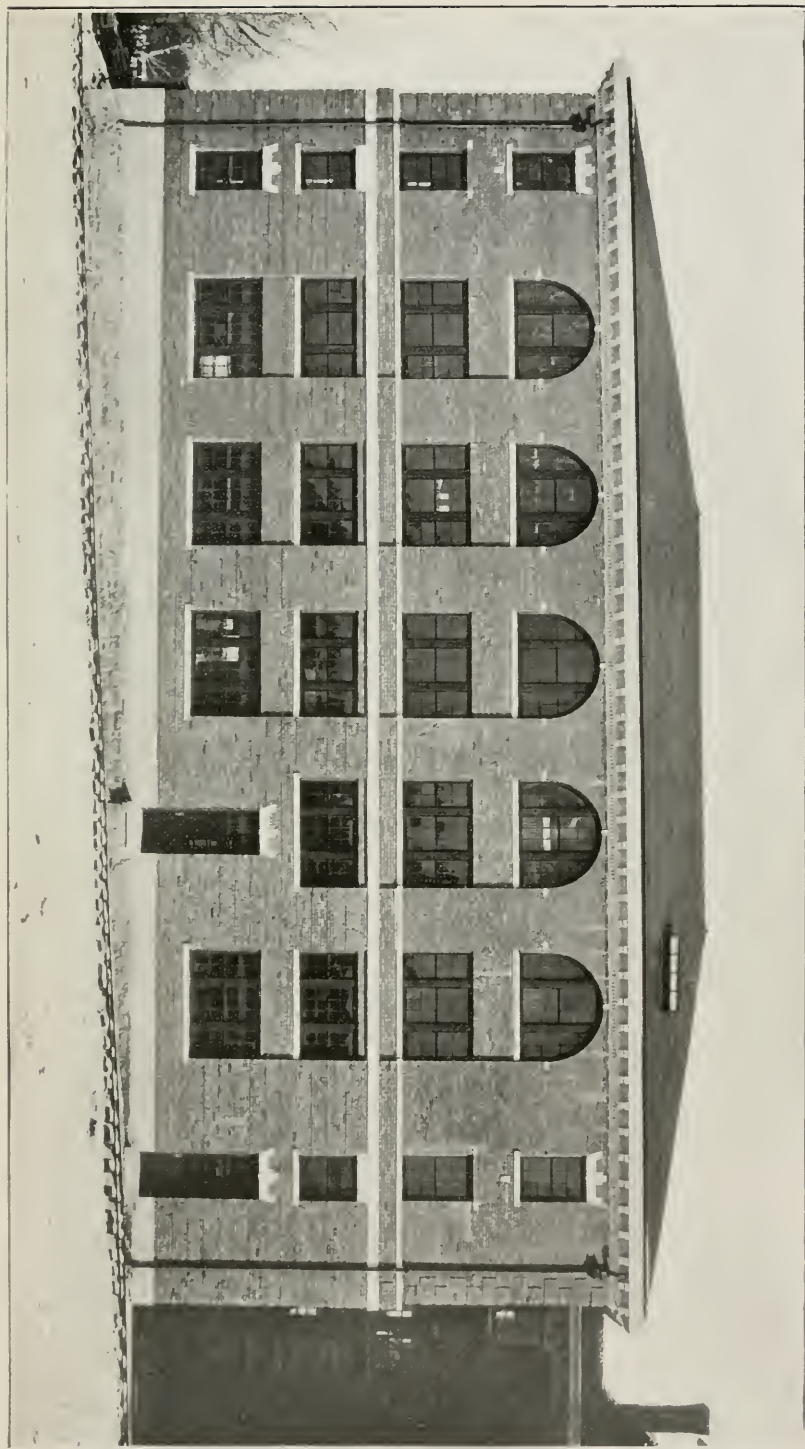
FIG. 2.—AGRICULTURAL EDUCATION—NEVADA COLLEGE AND STATION, CHEMISTRY BUILDING.



FIG. 1.—AGRICULTURAL EDUCATION—UNIVERSITY OF ILLINOIS, STUDENTS SETTING UP SELF-BINDERS.

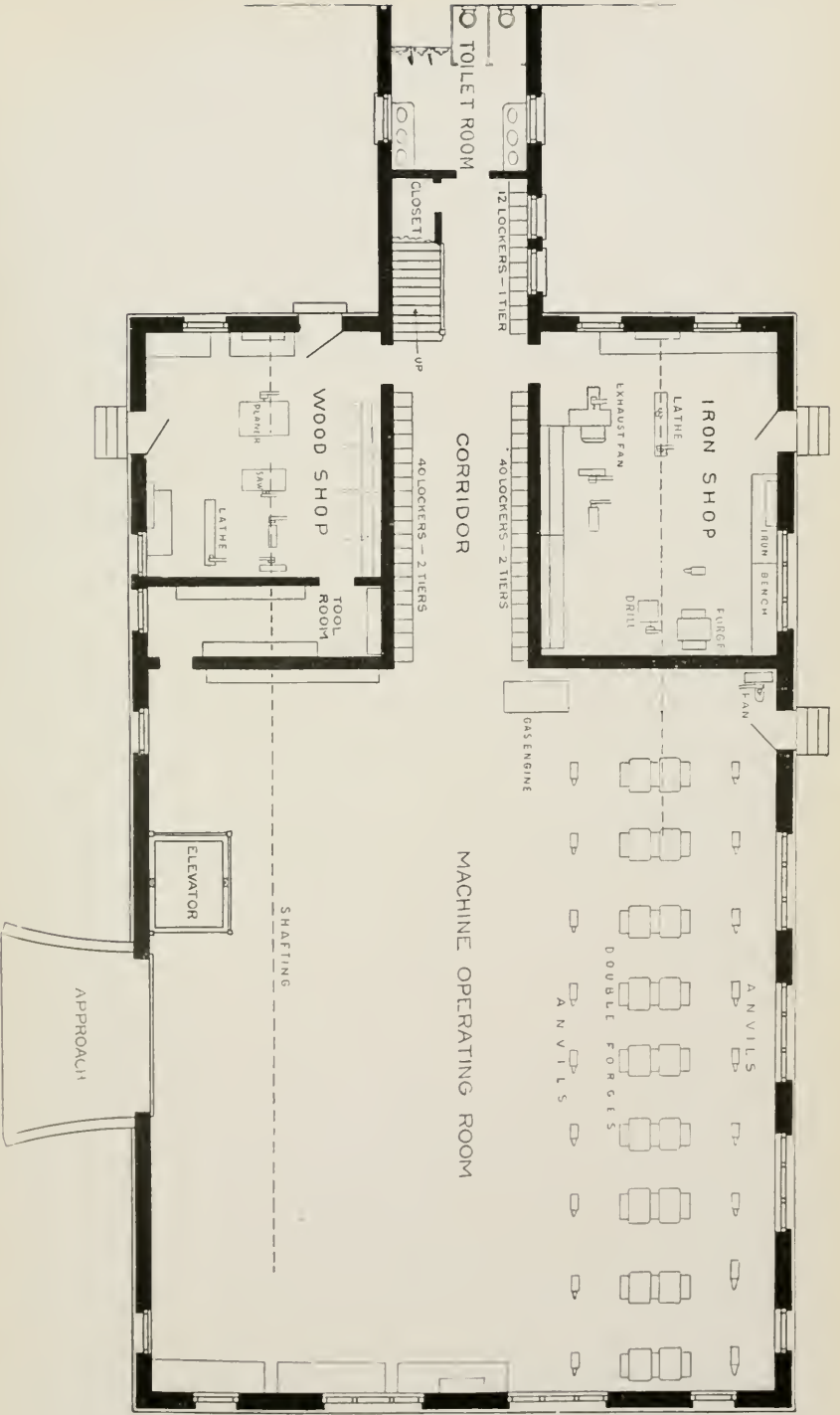


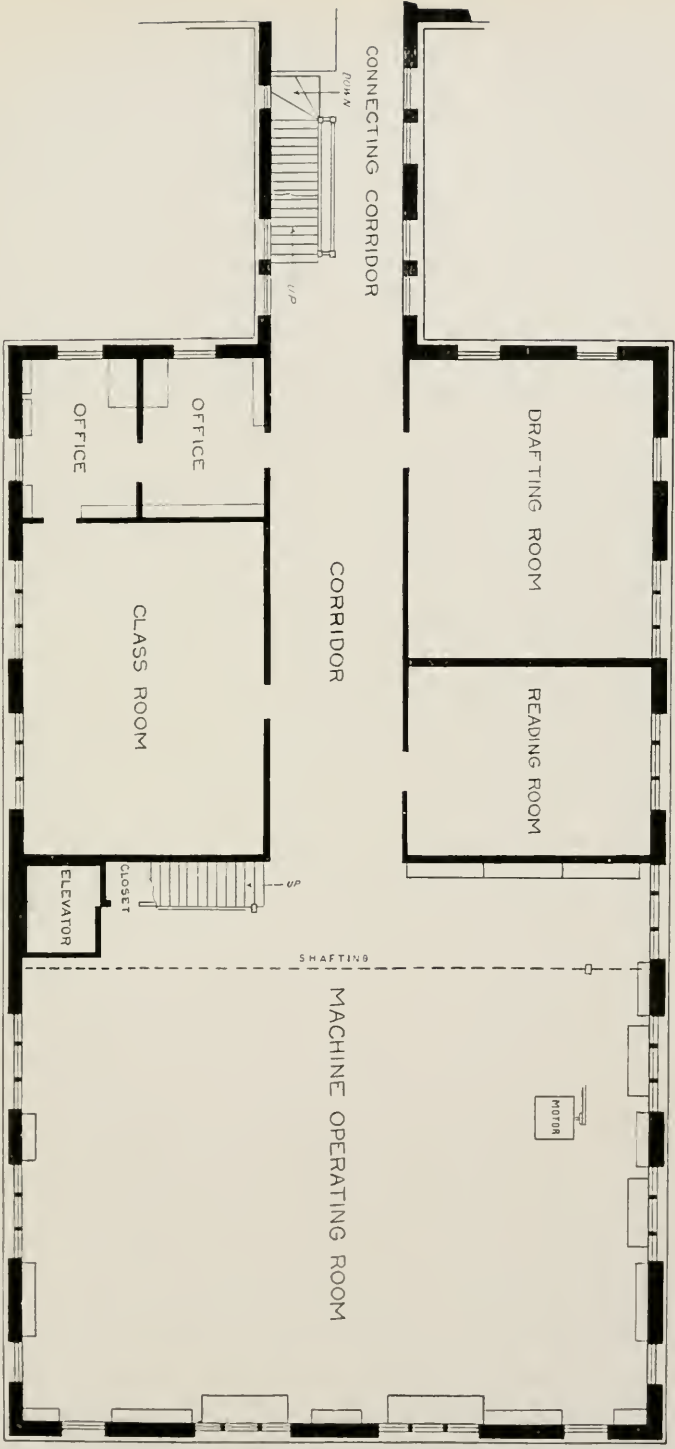
FIG. 2.—AGRICULTURAL EDUCATION—UNIVERSITY OF ILLINOIS, STUDENTS SETTING UP SELF-BINDERS.



AGRICULTURAL EDUCATION—IOWA COLLEGE, FARM MECHANICS BUILDING.

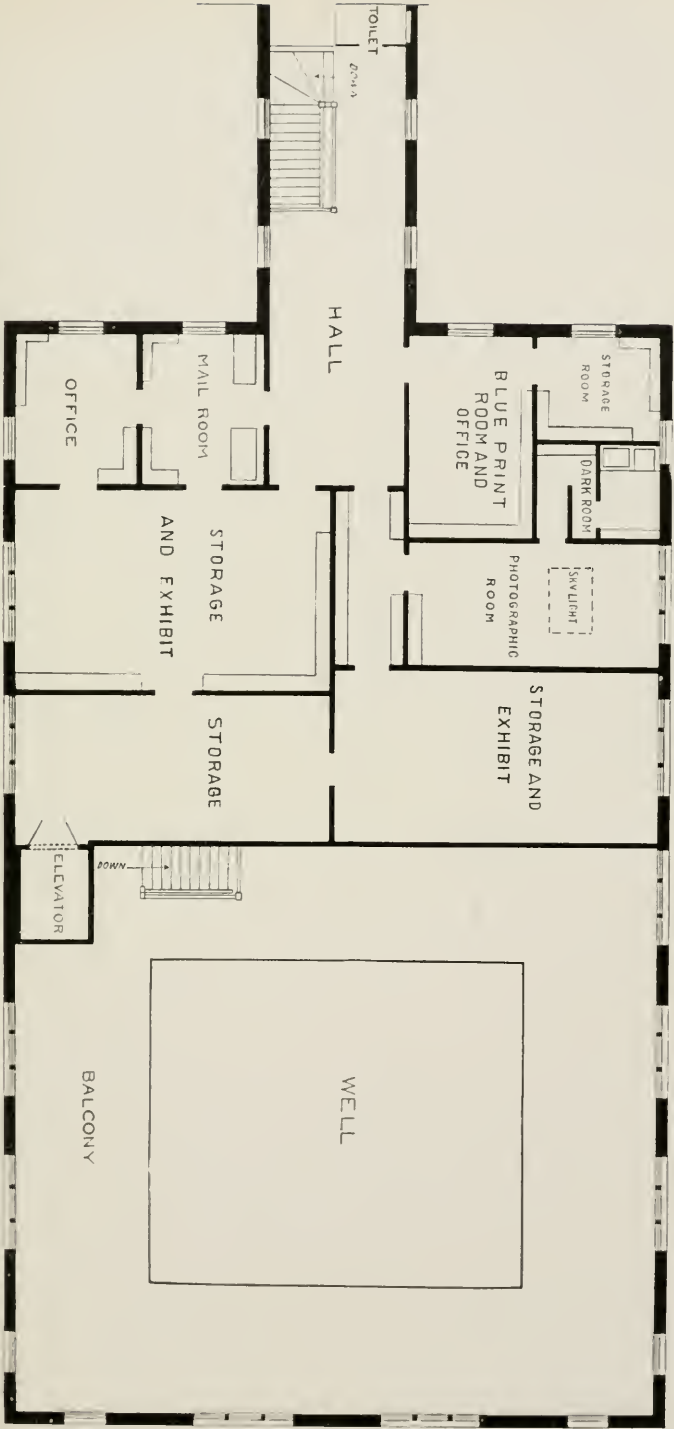
AGRICULTURAL EDUCATION—FIRST-FLOOR PLAN OF FARM MECHANICS BUILDING, IOWA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.





AGRICULTURAL EDUCATION—SECOND-FLOOR PLAN OF FARM MECHANICS BUILDING, IOWA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.

AGRICULTURAL EDUCATION—BALCONY AND THIRD-FLOOR PLAN OF FARM MECHANICS BUILDING, IOWA COLLEGE OF AGRICULTURE AND MECHANIC ARTS.



smaller machine room 51 feet 7 inches by the width of the building. This room will be used for setting up, operating, and testing various kinds of farm machinery, such as binders, mowers, corn planters, corn shredders, plows, wagons, etc. The connection with the main building is upon this floor.

The balcony and third floor (Pl. L) will be used for storing farm machinery not in use, and will contain an office for assistants in the department, a mailing room, and several storage rooms. Photographie and dark rooms for instructing the students of this department in photography will be located on this floor.

The building has a large elevator with openings on each floor and balcony. It is very substantially constructed of brick, stone, and steel, and is fireproof throughout. The cost, including heating, plumbing, furniture, and other equipment, will be between \$65,000 and \$70,000. Those familiar with such buildings state that when completed it will be the best and most thoroughly equipped building for instruction in farm mechanics in this or any other country.

Although this department is new at the college, it already has considerable material in the way of equipment. A 12-horsepower steam engine has been donated by a thrashing-machine company, to be used for instruction purposes, and a wagon company has furnished a farm wagon especially constructed for experimental work. The equipment of this wagon includes 10 sets of wheels of different heights and different widths of tire, to be used in tests to determine the best kinds of wheels for different roads, and sets of roller and ball-bearing axles, which will be tested and compared with the ordinary friction axles to determine the relative draft. The roller bearings were especially manufactured for this wagon and are thought to be the first roller bearings used on a farm wagon. A steel grain tank, having a capacity of 150 bushels, also goes with the wagon. The department is also provided with a newly-invented dynamometer which registers maximum and minimum drafts on a sheet of paper, and by an ingenious device shows the average draft during the test.

It will be the aim of the department to cooperate with the implement manufacturers in various ways. A friendly spirit has already been exhibited by these manufacturers. Quite a number of machines have already been received from them which will be used for practice work by the students, and many others have been promised as soon as the new building is ready to receive them. Representatives of these implement manufacturers will be invited to lecture before the students in farm mechanics from time to time, explaining in detail the construction of the machines which they are manufacturing, with the aid of specimens of these machines for illustration. In this way it is hoped to obtain for the students the best possible information on implement construction by men who are specialists in their lines.

The aim will be to make the collegiate course thoroughly practical. Students will be trained in the fundamental principles of construction of farm machinery, and in the setting up, operating, and adjusting of various kinds of implements. Besides farm machinery, the department embraces instruction in farm drainage, road construction, irrigation, planning farm buildings, mechanical drawing, carpentering, blacksmithing, and horseshoeing. Courses are provided in farm and field machinery, in farm power machinery, in drainage, and farm buildings, and opportunity is offered for postgraduate work. A number of postgraduate students are taking farm mechanics this year as a major study, with the expectation of fitting themselves for teaching this subject, and many inquiries are being received from prospective students.

The new department is in charge of Prof. C. J. Zintheo, recently instructor in agricultural engineering at the North Dakota Agricultural College, who was formerly in the employ of a large implement concern and has had experience in both the practical and theoretical aspects of the subject.

At the College of Agriculture of the University of Minnesota a course in rural engineering is offered, which includes the following topics:

"Subduing new prairie and timber soils, farm drainage, irrigation and irrigation works, tillage of crops, roads, their financial support, their location, construction, and maintenance, farm buildings, farm fences, farm implements and machinery."

In the short course for farmers at this institution instruction regarding farm mechanics and implements is given in accordance with the following outline:

Farm mechanics.—The instruction given in this subject will consist of lectures on farm mechanics, taking up such subjects as pumps, farm water systems, windmills, the general principles of steam and gasoline engines, placing shafting, pulleys, and belts; pipe fitting, soldering, etc. Some instruction will also be given on sharpening and using hand tools, such as saws, planes, chisels, and other tools necessary in farm practice.

Farm implements.—The lectures on farm implements will be illustrated as far as possible by samples. Stereopticon views will be made use of in illustrating machines that can not well be taken to the class room. It is the aim in these lectures to bring out the lines covering the draft of implements and the objects attained by their use. Suggestions will be made on selection of implements adapted to the various kinds of work. The care of implements when not in use will also be discussed, and an attempt made to give as fully as possible all information that will be beneficial in the care and handling of farm machinery.

Similar subjects are also taught in the agricultural high school connected with this college.

At the North Dakota Agricultural College instruction is given in the regular course regarding road construction, drainage, irrigation, farm buildings and machinery, and the programme for these subjects in the short course is as follows:

Farm mechanics.—Three lectures on "Laying out the farm" will consider the selection of building sites, location of farm buildings, and the division of the farm into fields. Twelve lectures on "Construction of Buildings and Works" will discuss the principles of construction, giving plans and specifications and estimates of the cost of farm buildings, the water system, sewerage and drainage, roads and fences, etc. Two lectures are given on the elementary principles of physics, upon which farm mechanics depend. Nine lectures disclose the principles involved in the use of the lever, evener, wheel and axle, pulley, inclined plane, screw, and wedge. Twenty-four lectures on "Construction and Use of Farm Machinery" will discuss the several classes of farm machinery in their order, the use of power machines, and the operation, care, and repairing of farm machinery.

At the College of Agriculture of the University of Wisconsin a course in farm engineering has for some time been given in the department of agricultural physics. This has included instruction relating to "farm machines and engines, the construction and maintenance of country roads, and the construction of farm building." In order to provide more adequately for work in these lines the State legislature, at its session in 1903, made an appropriation of \$15,000 for a farm-

engineering building, and G. N. Knapp, an engineer connected with the U. S. Geological Survey, has been appointed assistant professor of agricultural engineering.

In the announcement of courses of instruction in the College of Agriculture of Cornell University for 1903-4, as reorganized under the directorship of Prof. L. H. Bailey, farm mechanics and engineering are distinctly recognized, and two courses are offered, as follows:

Farm mechanics and engineering.—Lectures and recitations upon selecting, planning, and equipping farms, building roads, farm vehicles and machinery, power, water, and drainage. Practice in leveling and laying drains, dynamometer, and other tests of wagons and farm implements. Special instruction will be given on rural roads, and it is expected that a piece of actual road will be constructed each year.

Farm buildings.—Study and designing of farm buildings. Open to seniors and to others by special permission.

In order to aid the movement for the more complete recognition of rural engineering in our agricultural colleges and experiment stations and the United States Department of Agriculture, the Association of American Agricultural Colleges and Experiment Stations has appointed a standing committee on rural engineering, which submitted the following report at the convention of the association held in Washington, D. C., November 17-19, 1903:

At the last meeting of the Association of Agricultural Colleges and Experiment Stations the following resolution was adopted:

“Whereas, The agricultural colleges and experiment stations, as well as the U. S. Department of Agriculture, are broadening their work relating to irrigation and farm machinery and other lines of agricultural engineering, and there is pressing need of the more definite formation of plans for this work: Therefore be it

“*Resolved*, That this association make provision for the appointment of a standing committee on agricultural engineering to consist of five members, and that it be made the duty of this committee to cooperate with the Department of Agriculture in promoting education and research along the different lines of agricultural engineering.”

Your committee, appointed in pursuance of this resolution, begs leave to submit the following progress report:

Rural engineering, as defined in Circular 45 of the Office of Experiment Stations, is “the science and art of laying out farms, designing and constructing farm buildings and works, and making and using farm implements and machinery.”

A careful examination of existing conditions in the United States leads to a belief that there should be a strengthening of the courses of instruction in these subjects in our colleges, and the inauguration of comprehensive investigations and research work to ascertain the best practice in this and other lands and provide up-to-date information for instruction in our institutions of learning. This is equally true, whether the opportunities for students or the needs of the American farmers are considered. The field of practical usefulness for the one and the need of the other are alike extensive. In support of these conclusions we submit the following facts:

The comparatively large areas of American farms makes the laying out and arrangement of the different fields a matter of especial importance to our farmers. In order to maintain the fertility of the soil, rotation of crops must be practiced. To do this, fields should have such areas and such number as will make a regular system of rotation feasible. This gives an opportunity for the exercise of skill and intelligence, and, in connection with the building of roads leading from farm build-

ings to different parts of the farm, may involve marked economy or serious waste in the expenses of construction and in the distances traveled in going to and from the fields. It is therefore one of the things to which attention should be directed in our institutions of learning.

Closely related to the arrangement of fields is the construction and grouping of farm houses and farm buildings, not only to secure efficiency and economy, but to contribute to the healthfulness and attractiveness of farm life. There is no doubt that present conditions in these particulars in the United States are inferior to those in most European countries, and it is equally certain that improving the conditions of farm life will have much to do with determining whether the exodus of people from the country to the cities will be checked or become greater in the future than in the past.

In the construction of farm buildings, both barns and houses, the farmer is almost entirely dependent on his own knowledge and ingenuity in preparing plans and often in their execution. The designing of city buildings is largely in the hands of architects and engineers, and they are constructed by expert mechanics. They have, therefore, a finish and convenience which add largely to the attractiveness of city life. In the country, however, exactly the reverse is true. The great majority of farm buildings are unsatisfactory, whether considered from the standpoint of appearance, durability, adaptability to the work to be done, healthfulness, or pleasantness for the occupants. Some problems in connection with farm buildings need careful study. Among these is ventilation. The fact is we do not know either the effect of poor ventilation or the most efficient means of securing good ventilation. But the majority of the improvements to be wrought do not require research so much as the application of skill and ingenuity in design. One illustration of this is the fact that nothing is of more service in a home than a convenient water system. Much of the dislike which many women have to farm life comes, consciously or unconsciously, from the heavy work of handling water in cooking and washing, all of which could be easily saved by the adoption of readily available means. There is no reason why a farmhouse should not be as attractive as a city house, and there is no reason why the grounds surrounding farmhouses should not be made as attractive as city parks. It is largely because farm life and the farm home are not attractive that many of the enterprising, aggressive youth of the country flock to the cities.

Heretofore, nearly all farm buildings have been built of wood. A change in this direction is inevitable in the near future. Timber is becoming scarce and costly and must be supplemented by brick, stone, or concrete. We ought to begin in the near future to determine the relative value and cost of these different materials, and this is particularly a work for the colleges and stations. The character of farm buildings has also changed greatly in the past quarter of a century. Formerly they were simply storage places for grain or shelters for live stock. With the introduction of feed cutters, silos, power churns, centrifugal cream separators, and scores of other machines formerly unknown, these buildings are becoming as complex in their designs and uses as factories, and there is need of scientific study to determine the most economical designs to fulfill these different requirements.

Another reason for strengthening these courses of study is the fact that all of the public lands susceptible of cultivation in their natural condition have been taken up, so that this outlet for our growing population is closed. We have, however, large areas of land which, when drained or irrigated, can be settled upon and cultivated. The importance of irrigation is manifest from the statement that in two-fifths of the United States it is an absolute necessity to the existence of civilized life, and there is every reason to believe that it is destined to be an important means of increasing production throughout the whole country. But in order that fields may be irrigated they must be smoothed so that water will flow over them; and in order that the best results may be obtained the methods of applying water to crops to secure the

greatest economy in use and the largest yields must be studied, and the mutual relation of peoples who depend on the same water supply must be ascertained in order that we may have institutions which will secure harmony and justice.

An excellent beginning in the study of these questions has been made in a few institutions and by the Office of Experiment Stations, but there is a great field for the extension of both instruction and research and for a broader cooperation between the Department and the State institutions in both the cultural and engineering sides of this branch of agriculture.

Of wider application and scarcely less importance is the subject of drainage. The marsh and overflowed lands along our seacoast and the bottom lands bordering many of our rivers are at present unsightly, unproductive, and in some instances a menace to the health of surrounding districts. They need only to be diked and drained to be the most valuable lands in the country. The carrying out of these improvements will add immensely to the agricultural values of the country, and the work is certain to be undertaken in the near future. It involves, however, a larger knowledge of agricultural engineering than can now be obtained in our land-grant colleges. In fact, the profession of agricultural engineer, so prominent in Europe, is almost unknown in this country. Very little has been done in this country to develop a satisfactory drainage practice. The principles of drainage are understood by but few, and instruction in our colleges is meager and far from being up to date. Drainage laws are far from satisfactory and need to be modified because this work is beyond the means of individuals and must be carried out by organizations of large numbers of landowners associated under some definite legal plan. Careful work must be done in the study of the practical side of this subject, in determining the most effective methods of constructing ditches, in determining the kind of under-drains to be used, the depth at which they should be laid, the distance apart, etc.

We believe that in irrigation and drainage there is a field for cooperation between the Department of Agriculture and the experiment stations and colleges which ought to be more fully utilized, the Department of Agriculture coordinating the work of the stations and aiding them in carrying out original researches.

Associated with drainage and irrigation is another branch of hydraulic agriculture whose importance has not been properly realized. This is the terracing and draining of hillside farms in order to protect them from the destructive effects of erosion. It is an unfortunate fact that much of the activity of the last century in subduing and settling this country has been of a destructive character. Forests have been cut from the headwaters of streams; the hillsides which they protect have been exposed to the erosion of storms, and the evils of the work done by rainfall have been aggravated by the planting of these lands to crops which require clean culture, such as corn, tobacco, and cotton, which provide no binding material for the soil. As a result, much of the accumulated fertility has been carried down into the channels of streams, thus leaving thousands of acres of what was fertile land not many years ago scarred with gullies and practically abandoned to weeds and brush. We must stop this destructive style of farming if we are to maintain the prosperity and provide an adequate food supply for many sections in the eastern half of the United States. To find out how best to do this and to encourage farmers to begin action is a work which both the Department of Agriculture and the different State experiment stations should take up at once. The hill lands of France, Germany, and England are as fertile as they were a century ago, although many of them are devoted to cultivated crops. The credit for these results is due to the existence of a body of trained agricultural engineers, a class of professional men not now existing in the United States. The time has come when our colleges should lend themselves actively to this sort of training. The opportunities for employment in irrigation, drainage, and hillside protection are sufficiently great to make it an attractive course to young men having aptitude for such work, and it is the field to which we must look for the

largest results in the extension of our productive area and in the conservation of the fertility of much of the land now being farmed.

Another branch of rural engineering is the construction of country roads. Increase in population in our cities has resulted in larger areas being devoted to the production of perishable products—such as milk, garden truck, and fruit. The marketing of these has greatly increased the travel on country roads. The character of these products is such as to demand quick transportation, thus rendering it necessary that the roads should be hard and smooth, and this is being emphasized by the fact that the automobile and traction engine require a better roadway than the horse and cart. To build roads suited to the conditions of modern life, especially in the vicinity of cities, requires a knowledge of engineering wholly different from that of a quarter of a century ago and demands not only that the courses of instruction be strengthened, but that facilities be provided for experimentation regarding the best materials to use.

It is believed, however, that the greatest opportunities for students and for the improvement of the general agricultural practice of this country will be found in the systematic study of the manufacture and use of agricultural machinery. This country is the greatest maker and user of farm machinery in the world, and it is due largely to this fact that we have become the most prosperous agricultural country in the world. It has enabled the farmer to pay the high prices for labor created by the competition of our manufactories and has taken away from farm life much of the drudgery of manual toil and made it in the best sense an intellectual pursuit. Improvements in machinery have brought about a steady reduction in the cost of production, notwithstanding the steady rise in wages. The self-binder enables one man to accomplish the work done by four men with the best machinery in use at the close of the civil war. The check-row corn planter and the two-horse cultivator have, according to a recent writer, lessened by more than half the labor cost of producing a bushel of Indian corn. Machinery has enabled the eastern farmer to adopt intensive farming. The windmill pumps the water used in the dairy, the centrifugal separator skims the milk, and water or wind power runs the churn. The gasoline or steam motor is beginning to haul the product of the truck farm to the city market, rendering the farmer equally independent of horses and railways.

In the same way it has enabled the western farmer to plant and harvest large areas, notwithstanding the scanty labor supply to be found there. Last year a traction engine in California cut and thrashed over a hundred acres of wheat in a single day, doing the work of nearly one hundred horses with modern mowing and reaping machinery, and equaling the result accomplished by that many men and horses fifty years ago. Less than a century separates the operation of machines like this and the cutting of grain with the scythe and thrashing it with the flail, and the improvements which have been made in harvesting machinery have been duplicated in many other lines of farm work. There are now traction engines which plow 30 acres of ground in a day. Recently a gasoline motor has been invented which promises to be as successful in displacing the horse in certain lines of work on the farm as the automobile is on the country roads.

The demands which these changes are making on the farmer for a knowledge of the principles of mechanics and for a certain amount of skill in their application is so much greater than it was a century ago that it can not be stated as a percentage. The question we have to consider is whether we have recognized this change in the courses of instruction in our agricultural colleges. Your committee is unanimously of the opinion that we have not, and that the facilities for instruction are not in keeping with the importance of this branch of agriculture. In the majority of institutions the same kind of mechanical training is given agricultural students as to students who expect to work in factories, while the work to be done by the farmer in the use of machines and tools is of a radically different character. On the farm one man must do many kinds of work, and hence must use many different kinds of

tools; in shops and factories one man does one thing or a few things only. This highly developed specialization produces efficient labor. A man uses a tool until he understands it thoroughly, recognizes immediately any defect, acquires a feeling of ownership in it, gives it constant care, and is often able to make improvements in its construction. All this is very different in the experience of the farmer. He uses one machine only a short time, and then must take up another. What is learned about the construction and use of a machine at one time is largely lost before it is again called into use. The result of all this is that the farmer fails to develop that interest and mechanical sense which are necessary to the highest efficiency in the operation of the complex machinery which now forms a part of the equipment of every modern farm.

The records of the last census show that over one hundred million dollars worth of farm machinery is made and sold each year. The saving which would come to the people of this country by extending the life of each machine one year would be an immense addition to the annual profits of our farmers. This saving can be more than realized and it can be augmented by the greater efficiency which would come from expert care and management. At present it is notorious that the American farmer, with all his mechanical aptitude and inventive skill, is behind the other leading agricultural countries in his management and care of agricultural machinery. It is believed that this is largely due to the neglect of this subject in our schools. In Germany, France, and more recently in England, a well-equipped laboratory for testing agricultural machines and a museum filled with samples of machines of different patterns for examination by students is held to be as essential to proper instruction as a chemical laboratory. The first floor of the agricultural high school at Berlin contains a museum in which are found the best types of agricultural implements of the United States, England, and Germany. The student who makes proper use of that museum has a better understanding of the principles which govern the construction of the tools he is to use and the modifications to conform to different uses than it would be possible for him to acquire in any other way, and it is a kind of training especially demanded by the conditions of American farm life.

This training in the agricultural institutions of Germany is regarded there as of the highest value not only by farmers but by manufacturers. It gives them trained workmen in their shops; it gives them trained agents to extend their export trade in different countries. The union of agricultural and mechanical knowledge in their employees and agents has enabled German implement makers to greatly increase their export trade, and it is believed that the same result would follow similar training here. If we are to maintain our standing as a producing and manufacturing nation we must maintain our superiority as designers and users of farm machinery, and this can be best promoted by bringing the trained intelligence of the experts of the Department of Agriculture and of the students and professors of our agricultural colleges to bear on this problem. A few colleges have created departments for instruction in certain branches of rural engineering, the departments of irrigation engineering in Colorado and California being illustrations of this, and a number of colleges are now considering the establishment of courses in rural engineering with farm mechanics as the leading feature, and there is much interest in the development of these courses as independent lines of work. Among these are the colleges of agriculture in Illinois, Wisconsin, Minnesota, Iowa, and North Dakota. In each case this work has been inaugurated as a branch of instruction in agronomy. While this may answer as a beginning, the importance of the allied branches of rural engineering taken together entitles it to be made an independent department of instruction, having equal rank with agronomy or animal industry as they have been established in a number of institutions. The scheme outlined in the fifth report of the committee on methods of teaching agriculture, and published in Circular 45 of the Office of Experiment Stations, brings together in a logical way the scattered

instruction which bears on this branch of agriculture and furnishes a systematic and well-rounded course. Such departments are needed to furnish opportunities for specialization by students who wish to prepare themselves for leadership along these lines of work, and would furnish a field for experimentation and systematic training for farmers in the subjects which to-day constitute the most important factors in the expenses and profits of American agriculture.

The same policy should be followed in the organization of the work of the Department of Agriculture. This Department is now doing important and useful work in a number of branches of rural engineering, but its influence on the development of the country and the effectiveness of the investigators would be greatly promoted if all of these related lines of work were gathered together in one division, instead of being made simply incidents of the work of several bureaus organized to do other things, as is now the case. It is believed that the importance of these subjects warrants the adoption of this plan at an early date. One of the reasons for believing this is the consideration given to these subjects in other countries where their importance is far less than with us. The bureau of hydraulic agriculture is one of the leading bureaus of the agricultural department of France. It includes only drainage and irrigation. The relative importance of these subjects in France and this country is shown by the fact that France has only 400,000 acres of irrigated land, while we have nearly 8,000,000 acres irrigated and the work is still in its infancy. In France irrigation is not a necessity—only an aid to agriculture. In two-fifths of the United States it is a necessity for civilized life. Furthermore, the conditions which have been created in this country by the character of our irrigation development give to the irrigation investigations of the Department of Agriculture a significance and importance not possessed by similar work in any other country in the world.

Over 8,000,000 acres of sagebrush desert land has been reclaimed by the unaided efforts of farmers, without any assistance from either the Federal Government or the States, in such a manner as to produce good crops. This task is one of the greatest achievements of the agricultural classes of this or any other continent. It has involved an amount of experimenting and a waste of money in failures and partial failures which is inconceivable to those not practically familiar with western conditions. This task, however, has not been completed. Some of the most difficult problems yet remain to be solved. Some of the things which remain to be done are to determine the amount of water which each farmer should receive, and to provide for an equitable distribution of the waters of streams. The uncertainty regarding rights to water is one of the grievous evils which confront western farmers. It is believed that if these rights were so well established and protected that each farmer could know certainly that in times of scarcity he would receive his proper share, the value of each one of these 8,000,000 acres would be increased on an average at least \$5, or an aggregate of \$40,000,000 in all. But this is only one feature of the gain. Such a change will put an end to litigation and to the enormous expenditure of time and money which it involves.

The watering of 8,000,000 acres of land involves the handling of an enormous quantity of water each year. If this water could be transferred from the streams to the field with the same system and skill that is exercised in the operation of some of our railroads, or that is shown in the distribution of water in some of the best districts of Italy and France, the gain in the saving of water and in the increased production of crops would be something enormous. At present in many parts of the West there is either a very defective system or no system at all, and a competent investigator has estimated that we are losing each year at least \$10,000,000 on account of the faulty distribution of appropriated waters. These figures are sufficient to show the necessity for a systematic study of these questions by the Department of Agriculture and to show also why, with the increase in the cultivated area which is each year going on,

the necessity for these investigations and their importance to the whole country is destined to increase.

There is no country where drainage problems are as important as in the United States. The swamp and overflowed lands of this country if reclaimed will equal in productive capacity practically the whole of France, yet the problems of drainage and diking, on which their successful reclamation depends, have as yet received but little study, and the practice in both directions is susceptible of great improvement.

The construction of country roads is an essential feature of rural engineering. The great extent of our country, its recent settlement, and the necessity for extensive improvements in those directions, make it an important factor in the work of the Department of Agriculture. The necessity for improvements in roads has been referred to above, but the study of the character of these improvements involves also a study of the kind of machines and vehicles that are to travel on them. Along with the study of road making should go a study of the limitations and requirements of traction engines, automobiles, and all of the new forms of transportation which are becoming an essential factor of American farm life. The relation of the problems of farm machinery to irrigation and drainage has already been shown by the necessity of including in these investigations a study of the applications of power to pumping, because pumping is the only means of supplying water for irrigation in certain districts and an essential means of removing water from over-irrigated lands in others. The study of pumping has, of necessity, led to a study of the relative economy and effectiveness of different forms of power for the operation of pumps. There is equal need of similar studies of the applications of the different forms of power, whether steam, gasoline, electricity, water, or wind power in the other branches of farm work, and these are being brought home each year with increasing force to both the manufacturers and users of farm machinery. We believe, therefore, that all these related lines of work should be brought together in the Department of Agriculture in a single bureau, exactly as all the related lines of instruction in these subjects should be brought together in one distinct course in our colleges.

The necessity for increased attention to these subjects has been recognized by both the Secretary of Agriculture and the Director of the Office of Experiment Stations. Dr. True has recommended that the name "irrigation investigations" be changed to "irrigation and agricultural engineering" in order to more correctly indicate the nature of the work being done, and the Secretary of Agriculture, on the recommendation of Dr. True, has included in his estimates to Congress a request for this change and for an increased appropriation to be expended in making investigations in the applications of power to farm machinery, the direction of these inquiries, as indicated in Dr. True's report, to be:

"(1) Preliminary work in the collection and publication of information regarding the evolution, character, and uses of farm implements and machinery in this and other countries. This is important because the available literature on the subject is scattered, fragmentary, and out of date. A small beginning has just been made in this direction in a bulletin on The Evolution of Reaping Machines recently published by this Office, and another bulletin describing corn-harvesting machinery, which is being prepared.

"(2) Laboratory and practical tests, involving a study of principles of construction and methods of operation of farm implements and machinery with special reference to efficiency and economy. These might very properly include certain strictly technical inquiries regarding the fundamental nature of the various mechanical farm operations with a view to suggesting the best means of performing them with the implements and machines at present available, or with others, the construction of which will be indicated by the results of the inquiries. Such inquiries would require considerable laboratory equipment, but the results obtained would be useful to the

farmer by securing for him the most efficient implement or machine for performing the desired operation, and to the manufacturer by assisting him in the construction of the desired implements and machines."

This committee recommends that the association declare itself in favor of the creation of separate departments of rural engineering in the colleges, that it give its hearty support to the efforts of the Secretary of Agriculture to extend the work of his Department along these lines, and that the executive committee be instructed to urge upon Congress the importance of giving the Department liberal appropriations for these purposes.

COURSES IN RURAL ECONOMY.

There has thus far been comparatively little instruction given in our agricultural colleges on subjects connected with the economic problems of agriculture. Attention was called to this in the fifth report of the committee on teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations in 1900, when a tentative course in rural economy was outlined. Since then there has been a somewhat greater interest in this subject manifested by the managers of our agricultural colleges, and in a few institutions we have the beginnings of definite courses of instruction along these lines.

At the College of Agriculture of the Ohio State University a course on the history of agriculture and rural economics is offered, which consists of "lectures and recitations upon the history of agriculture; present agricultural methods in various countries; cost and relative profits of various farm operations and systems." Prof. H. C. Price, who has recently been appointed dean of this college, is also designated professor of rural economy.

In the College of Agriculture of the University of Minnesota a course in "agricultural economics" is offered, which includes the following topics:

Farm management, systems of farming, planning farms, fields, crops, stock, labor, farm finances, sales, prices, agricultural statistics, production, exports, wages, land laws, ownership, taxes, organizations.

Special attention has also been given by this institution to original investigations regarding the cost of production of agricultural crops, in cooperation with the Bureau of Statistics of this Department.

At the University of Wisconsin a course in agricultural economics is given by Dr. H. C. Taylor, instructor in commerce. "This course treats of those principles which underlie the prosperity of the farmer and of all other classes in so far as they are dependent upon agriculture. The subject is divided into two parts. Part one considers the point of view of the farmer and those economic principles which underlie the management of a farm in such manner as will make it yield the largest net return. Part two discusses the point of view of the nation as a whole and those principles which should guide the statesman in his efforts to regulate and improve the agriculture of a country."

At the Rhode Island College of Agriculture and Mechanic Arts special attention is now being given to this subject. The following courses are offered:

Farm management.—Farm capital, permanent and floating; distribution of capital; labor and its efficiency; profit or loss from the use of machinery; farm advertising; inventory and accounts; types of farming considered from a business standpoint.

Rural economics.—History and development of agriculture; influence of location, climate, and other factors upon the agriculture of a country; relation of agriculture to other industries and to the body politic; farm law.

In the reorganized programme for courses of instruction in the College of Agriculture of Cornell University rural economy is given as one of the main branches of agriculture, and courses are offered in farm accounting and the economics and history of agriculture.

With a view to increasing interest in this subject, President Butterfield, of the Rhode Island Agricultural College, has been asked to outline a course of instruction suitable for the agricultural colleges, and attention is invited to his article as given in this report (p. 713).

In the agricultural institutions of Europe considerable attention is given to rural economy and courses of instruction have been quite definitely established. To indicate the nature and scope of these courses the following outline has been prepared:

RURAL ECONOMY IN EUROPEAN AGRICULTURAL SCHOOLS.

FRANCE.

In the higher agricultural schools of France rural economy and rural legislation are taught as constituting one course. The lectures on rural economy include the elements of political economy, rural economy proper, and agricultural legislation.

In teaching the elements of political economy the relation of the subject to rural economy is impressed upon the students and the object, character, and utility of the science are discussed. Political economy as taught in this course comprises a consideration of the production, circulation, distribution, and consumption of wealth, and under these different heads the following topics are included:

Production of wealth.—Production—its agencies, character, and purpose. Property and property rights. Primitive forms of land ownership. Labor. Liberty and division of labor. Capital—its character, origin, and function. Machinery in agriculture and other industries. Methods of production under modern social conditions.

Circulation of wealth.—Exchange. Theory of values. Money. Prices. Monometallism and bimetalism. Depreciation of the precious metals and commercial crises. The foreign trade of France. Theory of markets. Protection. History of French commerce since 1789.

Distribution of wealth.—Theory of economic rent. Interest and the variations in percentage of the same. Salaries and theories relating thereto. Population and the law of Malthus. Statistics on population in France and foreign countries.

Consumption of riches.—Luxuries. Imposts. The budget. Statistics and economics of the French system of finance.

Rural economy includes the study of the character and history of the subject as preliminary to a course outlined as follows:

Production of agricultural wealth.—Agencies of agricultural production. Land. Division of land properties. Reducing and increasing the size of farms in France and other countries. Statistics on the division of land properties. Divisions in crop production. Improvements of land. Valuation of farms. Rents in their relation to the fertility of the soil. Capital in agriculture, its utility and function. Capital invested and capital for running expenses. Elements of expense and theories relating thereto. Systems of farming. Change from one system to another according to economics or other conditions. Agricultural estates. A detailed monograph on some estates under different systems of management required. Organization and administration of estates. Methods of soil management. Direct returns. Rent for cash and on shares. Estates under managers or superintendents. Agricultural labor (men, animals, machines, periods of activity). Live stock and its economical aspects. Statistical and comparative study of plant and animal production in France and other countries.

Circulation of agricultural wealth.—Exchange. Division of agricultural labor and specialization in production. International commerce in agricultural products. The French system of customs, its history with reference to the products of the soil.

Credit.—Credit as based on real estate, personal property, or confidence. Credit institutions of France, such as the Credit Foncier and Credit Agricole. Mutual credit associations in France and other countries.

Distribution of agricultural wealth.—Distribution of proceeds among the factors of production. Fluctuations in rents and prices of land in France during the last century. Agricultural crises. Agricultural profits. Salaries and their variation.

Consumption of agricultural wealth.—Development of the consumption of agricultural products. Influence of markets on production. Agriculture and imposts. Distinction between imposts affecting the proprietor and those affecting the renter. Land tax. Comparisons with other countries.

Agricultural accounts.—Their utility. Net returns in agriculture. Methods of farm bookkeeping.

In addition to the above, lectures on agricultural colonization are given at the agricultural school at Grignon. These lectures have reference to Tunis. The following topics are considered: Land laws, crops, stock raising, organization and administration of estates, capital invested and profits.

The lectures on rural legislation present a study of civil, administrative, and commercial laws, together with other legislation of agricultural interest. The following is an outline of the three important subdivisions:

Civil law.—Study of the second book of the Civil Code. Contracts. Sales. Leases. Privileges and mortgages.

Administrative law.—Administrative jurisdiction. Administrative bodies and officers in arrondissements, departments, and the State. Powers of mayors and prefects. Water laws, roads, and waterways. Dispossession. Boundaries.

Commercial law.—Merchants and commercial transactions. Commercial jurisdiction. Commercial papers, bills of exchange, etc.

The class work is supplemented by excursions to different estates for the purpose of inspecting and studying the management.

The above outline is fairly representative of the study of rural economics in the *Institute Nationale Agronomique*, which stands at the head of the French system of agricultural schools and the three national schools of agriculture at Grignon, Rennes, and Montpellier. The supervision of these institutions is centralized in the ministry of agriculture, and the courses given in the studies common to all these schools are in general quite uniform.

The following outline represents the course as taught in the practical schools of agriculture, which are of a lower grade than the institutions above mentioned:

Elements of political economy.—Definitions: Wealth, labor, property, capital, exchange, value, price, money, credit, and banks. Markets. Lines of transportation. Commerce, domestic and foreign. Wages, imposts, population, theory of Malthus.

Elements of rural economy.—Factors of agricultural production. Land. Rent. Estimating landed property values. Capital in agriculture. System of farming. Renting for cash and on shares. Farms in charge of managers. Agricultural labor. Hand labor. Animal labor. Machines. Live stock and its economic relation. Principal systems of farming followed in France. Agricultural statistics of France.

Elements of rural legislation.—Distinction of property: Real estate, personal property, property rights. Marking and establishing boundaries. Fences. Party property and party rights. Planting. Building. Rights of passage. Farm rents.

Sales: Guaranties, exchanges, loans, mortgages. Societies. Syndicates. Mutual insurance. Culture of tobacco (in France under the direct supervision of the State). Destruction and protection of crops. Domestic animals, etc.

Adulteration of products. Various laws of interest to the farm.

In the French grammar schools in which a course in agriculture is given the following topics are considered in connection with the study of rural economy:

Landed property.—Division of the land. Proper means to prevent its inconveniences. Societies and meetings. Large, medium, and small farms.

Methods of management.—Personal direction and direction by manager. Renting for cash. Renting on shares. Rents. Proper methods to protect the interests of renters and proprietors. Farm laborers. Wages. Methods to remedy the depopulation of country districts. Utility of good roads. Assistance given by the State.

Agricultural mutuality.—Agricultural credit.

Agricultural institutions.—Comices. Societies. Syndicates. Agricultural instruction. Agronomic institute. National schools of agriculture. Practical schools of agriculture. Farm schools. Departmental professors of agriculture.

Distribution of production.—Agricultural statistics of France. Production and consumption. Imports and exports. Countries from which imported—products and quantities. Countries to which France exports its agricultural products—kinds and quantities. Agricultural statistics of the department; brief general review of the agricultural situation of the department; crops, stock, implements, capital for running expenses, etc. Production, consumption, imports, exports. Progress to be realized.

In many of the French schools the subject of agricultural book-keeping is not included in rural economy, but is taught separately.

BELGIUM.

In some of the Belgian institutions social, political, and rural economy were formerly taught as one subject, but at present rural economy is considered as a separate branch. In addition to rural economy proper, rural legislation, social and political economy, and agricultural bookkeeping are taught.

The following is an outline of the course in social and political economy given at the Agricultural Institute at Gembloux:

Production of wealth.—Agents and helps of production. Division of labor. Association. Methods of production as on large, medium, or small farms, or by cooperation. Condition of production. Individualism or socialism. Equilibrium in production.

Circulation of wealth.—Exchange. Money. Commerce. Credit.

Distribution and consumption of wealth.—Property rights. Hereditary rights. Contracts between employer and employee. Rent. Interest. Savings. Insurance. Luxury. Charity.

Public finance.—State properties. Imposts. Loans. Budget.

Lectures on the subject of rural economy are given during the third year of the college course. The subject is divided into six groups, consisting of a general consideration of the subject, soil, capital, labor, necessary and favorable elements, and production:

General consideration.—Factors instrumental in agricultural production—their relative value. Definitions. Limits of rural economy.

The soil.—Definitions. Rent. Land values. Appraising land properties. Land improvements.

Capital.—Running expenses. Investments. Circulating capital. Relation between investment and circulating capital. Chattels—live stock and implements.

Labor.—Wages. Foremen. Assistants. Day laborers. Contractors, etc.

Elements necessary or favorable to production.—Systems of culture. Rotations. Physiological, economical, and meteorological laws. Large, medium, and small farms. Renting lands on shares and for cash. Personal direction of the farm or by manager. Lands adapted to agriculture. Cooperation in agriculture. Syndicates. Comices. Agricultural credit.

Production.—Plant production: Cereals, forage plants, industrial crops. Market gardening. Animal production: Horses, cattle, sheep, swine, poultry. Agricultural industries: Sugar, breweries, distilleries, creameries, cheese factories, and their organizations.

The lectures in the course are supplemented by making estimates on land values, capital required for running expenses, quantities of feed consumed, management of the farm, labor needed on the farm, and by excursions for the purpose of observation.

Rural legislation.—Property rights. Accession. Use. Water rights. Culture. Harvesting. Bees. Contracts (labor contracts, leases). Sales (defects in animals annulling sales). Various laws and regulations. Rural police. Roads, etc. Elements of commercial law.

GREAT BRITAIN.

The courses in rural economy in the agricultural institutions of Great Britain are not very uniform. The term "rural economy" is

frequently used as designating economical farm management, and the branch of study which we are now considering is designated "rural economics." In some of the schools this branch, in connection with rural laws, is optional. The topics studied in a number of institutions are here briefly outlined.

Edinburgh School of Agricultural Science.—Food supply of the United Kingdom. Wages of agricultural labor. Profits of farms. Rent of land and cause of its variation. Contracts for the hire of land. Risks of long leases. Compensation for improvements. Fixity of tenure and its effects. Prices of agricultural products. Foreign competition. Effects of appreciation of gold and depreciation of silver. Effects of various imperial and local taxes on agriculture.

University of Aberdeen.—This institution offers a course of fifty hours in economic science as applied to agriculture in connection with farm bookkeeping. The lectures treat of general and agricultural economics. Under the last-mentioned study the following are the principal topics considered:

Rent of land and the cause of its variation. Profits of the farm. Wages of labor. Variations in efficiency of agricultural labor. Contracts for the hire of lands. Leases. Compensation for improvements and dilapidations. Fixity of tenure. Prices of agricultural produce. Food supply of the United Kingdom and foreign competition. Imperial and local taxes in relation to agriculture. Instruction in farm bookkeeping and accounts is also given. The text-book studied in connection with the course in economics is Walker's *Elementary Lessons in Political Economy*.

Edinburgh and East of Scotland Agricultural College.—A course of fifty lectures on economics as applied to agriculture is given in Edinburgh University by the professor of political economy.

Royal Agricultural College and Farm, Cirencester.—Laws of landed estates. Landlord and tenant. Highways and rights of way and water. Master and servant as affecting farmers, land stewards, and land agents. Farm animals—sale, purchase, hire, riding, and driving. Cattle diseases acts.

Durham College of Science.—The agricultural department of this institution gives a course in estate management, which includes a study of the laws relating to landed property.

Southeastern Agricultural College, Wye, Kent.—A course in agricultural law. Principles and practice of ordinary tenant right, and other valuations, with a knowledge of valuation tables. Nature and incidence of local and other taxation, and the various public and other charges affecting landed and house property.

Such matters as outlay or investment in agriculture are treated in the course on agronomy.

AUSTRIA.

An outline of rural economics and allied studies as taught in the Hochschule für Bodenkultur, the highest agricultural institution of

Austria, is here given. The institution offers courses in agronomy, forestry, and rural engineering, and a study of the topics mentioned below is given to all students:

Constitution and administration.—The State of Austria-Hungary. Administration of general and local interests. Administrative jurisdiction.

Civil rights.—Civilians and officials. Property and mortgage. Contracts. Cession. Defenses. Civil jurisdiction of Austria.

Administrative rights.—Police. Administration and population. Property transfer: Inseparable estates, division, inheritance, etc. Water. Mutuality. Roads. Railroads. Credit. Associations. Forests. Hunting and fishing. Fields and birds. Insects. Agricultural education. Rights of the poor.

Finances.—Receipts and expenditures. Budgets. Demands of the State. Imposts and contributions. Custom-houses. The credit of the State. Contraction and extinction of debts.

The different topics in the course are discussed and practical cases are examined. The students are required to draw up contracts and other legal documents.

Political economy.—Preliminary topics. Principal tendencies of political economy. Forms of private and collective economy. History of political economy and its theories from antiquity to the present day. Theories of values. Wealth and its estimation. The factors of production. Organization of production. Prices, monopolies, exchange, money. Credit—titles, banks, exchanges, paper money. Transportation. Commerce. Distribution of wealth. Socialism. Consumption of wealth.

Political economy applied to agricultural statistics.—Economics in general—their object, their tendencies, their foundations. Economics of production: Agricultural economics (legislation, agricultural credit, mutuality, instruction, public improvements); economics of forestry, mines, industries, and commerce. Economics of population. Statistics: Small and large farms; division and restriction of the same; relative importance of various agricultural products.

Labor and social reform.—Historical valuation of labor; division of labor; liberty of labor, etc. Conditions of industrial and agricultural labors from an economical and social standpoint. Social questions arising from conditions of labor. The most important social theories. What is social reform? Results obtained.

The most important questions in connection with these different branches are discussed by the students in class work.

The subject of rural economy proper is taught in the course in agronomy. In teaching the subject the principal object is to present methods for the organization and direction of a certain farm or estate under given, natural, and economic conditions.

General topics.—Object of rural economy. Factors of agricultural production. Soil. Capital invested. Capital for running expenses. Labor. Laborers and other agents. Methods of management and system of farming.

Special topics.—Organization of an agricultural estate—estimates, systematizing, etc. Management, with a study in detail of the books to be kept, either in single or double entry. Taxation.

The exercises in connection with this study consist in estimating the value of certain estates, calculating the commercial value of fertilizers and feeds, planning rotations, outlining the production of estates,

studying the loss of plant food, and giving conclusions as to the influence of a certain system of farming on the soil. Books are kept in single and double entry and practical exercises in farm practice are given.

In the course in forestry rural economy as taught has reference to the value and management of forests, and in the course in agricultural engineering the object of the lectures given is to impress upon the student the importance of always considering and undertaking from an economical standpoint.

GERMANY.

The subject of rural economy at the Royal Agricultural High School, at Berlin, is taught by means of lectures in the class room and by deliberation and discussions in the seminar. The class-room work consists of lectures on economic problems in their relation to agriculture, on rural jurisprudence, and on such phases of legislation as are of interest and importance to the farmer, surveyor, and agricultural engineer. A total of four hours per week is devoted to the lectures on all the different topics. In addition to this class-room work in the high-school, students attend lectures at the university on such subjects as finance, socialism, protection, free trade, etc. The plan of the course presupposes a thorough knowledge of the principles of economics.

The economic seminar was organized in 1889. It has continuously increased from the beginning in influence and numerical strength, and its average number of members at the present time is about seventy. Its membership is composed of regular students of the school, post-graduates, persons pursuing work in jurisprudence, political economy, philosophy, and history, and judges and other government officials whose work falls within this sphere. The seminar convenes once a week and has two-hour sessions.

The purpose of the seminar is to deepen the knowledge gained from class-room work and lectures, and to prepare the members for original investigation of economic problems. Each student is required to write a dissertation on some subject, usually of his own choice, and to lecture on the same before the seminar. After the subject has been presented it is taken up for discussion by the members. This work is supplemented by excursions to factories, estates, laboring communities, eleemosynary institutions, and other establishments which are of economic, social, or political interest. The seminar is provided with a library containing numerous works on agricultural, statistical, and economic subjects.

The methods of the seminar are considered more effective than the ordinary course of lectures, and also better adapted to prepare the student for original work and to lead him into the investigation of

certain problems. The excursions made by the student are intended for the purpose of gaining closer and more accurate knowledge of such conditions as may have a direct bearing on economics in general and rural economics in particular. It is of interest to note the kinds of work undertaken by the seminar, and for this purpose a list of titles of dissertations is here given: The Ability of the Small and Medium Sized Land Property to Compete with the Larger Estate; The Berlin Irrigation Fields; The Russian Farmers' Bank, with Special Reference to its Influence in Poland; The Economic Importance of Siberia; Theory of Agricultural Associations; The Economic Importance of Machinery in Agriculture; Agricultural Labor Conditions; Agricultural Work of Women (written by a woman member of the seminar); The German Agricultural Society; The Extinction of Land Indebtedness; Agriculture and Colonization in Argentine; Causes Leading to Extensive and Intensive Agriculture in Different Parts of Germany; Economic Importance of Trust Funds, etc.

Sometimes work is undertaken by the student under the direction of the minister of agriculture. A plan to obtain information on the agricultural conditions of the different districts of the country has been devised by the minister, and in this connection many of the students study and report upon the agricultural conditions of a certain district. Expenses incurred in the pursuit of their work are sometimes deferred by the Government. The different districts are studied by different parties, but the lines of inquiry are uniform in order that the reports may be placed together and thus constitute a complete review of agricultural conditions for the Empire.

A large collection of reports from the administrative and judicial officials of the entire country on the actual change in the possession of lands as caused by inheritance was turned over to the seminar by the Government for arrangement, compilation, and publication. This work when completed will consist of a number of volumes.

The following outline represents the course in rural economy at the University of Göttingen. It was given in this form as early as 1875:

The estate.—Its size. External factors, such as political, social, and economic conditions. Facilities of communication and transportation and their influence on the management. Internal factors, such as condition and kind of soil, location of estate, its adaptation to certain purposes, etc., and their influence.

Investment capital.—Investment in land. Use of land. Different methods of management and their results (increase or decrease of working capital, limits of the increase and their extension, consolidation, and division). Investment in buildings and improvements. What is needed in this line. Construction of buildings and improvements. Maintenance of same.

Working capital.—Live stock required, and its maintenance. Utensils, implements, and machinery required, and keeping them in good condition. Seed, fertilizers, feeding stuffs, straw, household supplies, salable products, and cash on hand.

Labor.—Managers and overseers. Regularly hired labor. Day laborers.

Obtaining possession of land.—Purchase, renting, administration.

Farm management.—In general, whether extensive or intensive. Different systems of management. Field operations. Live stock—horses, cattle, sheep, swine, and poultry. Organization. Reports on condition of farm or estate. Plans for improvements and their execution. Plans of management and their fulfillment. Maintenance of the farm. Ordering and controlling ordinary business transactions. Keeping accounts.

Rural law.—Leases. Purposes of leases. Time. Rent. Mutual rights and obligations of one party to the other during time of lease. Leasable property—buildings, ground, fields, gardens, yards, and privileges. Purchases made by the lessee. Material left to him for use without financial consideration. Material reserved by the lessor. New conditions affecting the lease, such as sales, purchases, trades, partial annulment by mutual understanding, etc. Accidents. Industrial improvements. Personal relations.

Entering upon the lease.—Turning over the property at termination of lease. General and special stipulations. Assurance of fulfillment of terms of contract by both parties.

Systems of agriculture.

Theory of organizing estates.

The lectures on economics in the agricultural courses at the University of Halle treat in general of political economy; the science of finance; agricultural statistics; and agricultural, commercial, and administrative law. The knowledge gained from the course of lectures is applied by the students in work undertaken in an economic seminar which is under the direction of the professor of political economy, who also teaches the subject of agricultural statistics. This economic seminar is a feature of the university in general, its membership being composed of all students in economics, whether giving special attention to rural economics or to some other phase of the subject. The course as a whole is supplemented by lectures on State laws, constitutional rights, and politics, for the purpose of instructing the students in the duties of citizenship. These supplemental courses cover in general the field of civil government.

The course in economics given in the agricultural institute of the University of Königsberg includes lectures on the following subjects: Political economy, financial science, political importance of European and other nations, German colonial policy, money standards, German and Prussian civil law, inheritance and rights of succession in Prussia, German penal laws, history of German jurisprudence, Prussian administrative law, civil code of the Empire, and legislation pertaining to insurance.

A chair of economics was permanently established in the agricultural school at Hohenheim in 1873. Prior to that time lectures on economic subjects had been given by the secretary of the institution. The course as outlined at the establishment of the chair included, in addition to theoretical political economy, the consideration of economic conditions of practical and scientific tendencies with which provinces, States, and countries have to deal. It was further considered necessary to treat such current problems as socialism and the many other

questions which the use of machinery, greater facilities in communication and transportation, greater political liberties enjoyed to-day, and like changes have forced upon the present generation for solution. Lectures on financial science, civil government, and agricultural law also form a part of the course. Commercial law, agricultural book-keeping, and taxes and taxation are studied in connection with the course on farm management. As in some of the other institutions, so in the agricultural school at Hohenheim, social, political, and economic topics, especially those of interest at the time being, are studied and discussed in an economic seminar. The library of the institution contains about 18,200 volumes, of which about 1,500 are works on economic subjects.

In the agricultural winter schools of the Grand Duchy of Hesse the course on economics consists of lectures on general conditions of production, theory of values, money, forms of credit, exchange, agricultural societies, factors affecting agricultural pursuits, cost of agricultural production, systems of farming (individuals, corporations, intensive, extensive, crop production, raising of live stock, mixed farming), crop rotations, civil government, and agricultural law. Four hours weekly are devoted to the subject.

Two hours per week are given to the study of agricultural book-keeping, which includes single and double entry, American bookkeeping, trial balance, banking, and business transactions.

SHORT AND SPECIAL COURSES.

In the effort to meet the needs of various classes of students the agricultural colleges have been unusually active in recent years in organizing special and short courses of different kinds. In order to determine the status of this work in the United States generally, a summary of these courses as offered in the different States and Territories has been prepared during the past year by Mr. D. J. Crosby and published as Bulletin 139 of this Office. The general features of these courses are shown in the introduction to that bulletin, which is given herewith:

One of the features of the recent forward movement in agricultural education has been the development of agricultural courses of study lower in grade and shorter than the regular four-year collegiate course. Sixty-three agricultural colleges and schools receive funds from the Government. Forty-four of these have organized special or short courses. This has been done to meet the needs of several classes of young people, who may be classified somewhat roughly as follows: (1) Those preparing to enter a four-year agricultural course; (2) those desiring instruction in agricultural subjects, but having insufficient scholastic attainments to carry the full collegiate course; (3) those unable to leave home for an extended course, who desire instruction in some particular phase of agricultural science or wish to become proficient in some branch of agricultural practice; and (4) teachers desiring to prepare themselves to give instruction in nature study and elementary agriculture.

For students preparing to enter a four-year agricultural course, high-school agricultural courses two or three years in length have been organized; also in some instances one-year or two-year preparatory courses. These high-school courses also serve many more students as finishing courses—preparation for life work. This is the purpose served also by the so-called practical one-year and two-year agricultural courses organized for those of limited scholastic attainment—courses having a minimum of culture studies and pure science and a maximum of applied science. Thirty colleges now offer courses falling under one of these two classes, and all but nine of these courses are more than one year in length.

Great importance attaches to courses of this nature, and great care should be exercised in planning them, because it is the graduates of these courses more than the graduates of the four-year courses who go back to the farms. It will be said, and it is true, that the best and most thorough course of study is none too good for the farmer, that a man should be as well trained for the profession of farming as for the law or medicine; but it must be remembered that there were well-defined courses of study in law and medicine long centuries before the farmer was considered worthy of instruction. In these professions there is now a great body of trained men and specialists from whose ranks special positions may be filled, while in agriculture the men of scientific attainments are comparatively so few and the demand for them in college, station, and other attractive and remunerative positions is so great that few bachelor-degree men feel that they can afford to go back to the farm. For the present, then, and for some years to come, the college of agriculture will have an important mission to perform through its secondary and short courses in the training of young men for the practice of agriculture.

For those actually engaged in agricultural occupations—the farmers, dairymen, and fruit growers, and their sons and daughters who are unable to leave home during the busy seasons—the special winter courses have been organized. These courses vary in length from a week or ten days to ten or twelve weeks. They are in most cases severely practical. They center around the judging pavilion, the laboratory, the dairy, and the cheese room, with lectures and readings to supplement the practicums. The nature of these courses is even more varied than their length of term. Twenty-two colleges offer courses in general agriculture, including more or less thorough instruction in plant production, animal husbandry, dairying, poultry culture, etc.; nineteen offer courses in general dairying; three in creamery management; two in farm dairying; two in cheese making; five in animal husbandry; nine in horticulture; four in poultry culture; three in domestic science, with more or less of horticulture, floriculture, and like subjects adapted to the needs of young women; and one each in agronomy, bee culture, forestry, beet-sugar production, farm mechanics, correspondence courses, botany, bacteriology, and entomology. Two colleges offer courses designated agriculture and horticulture; two, courses designated agriculture and dairying; and one, a course in agriculture, horticulture, and mechanic arts. Most, if not all, of these courses include instruction in a number of subjects not indicated in the names of the courses. There are also a large number of practicum courses and lecture courses which are confined to a single line of practice, such as cereal judging, stock judging, and the destruction of noxious insects. Six colleges offer a total of forty-four such courses.

The special winter courses are the utility courses, important because of their influence on the present-day agricultural practice and because of the influence of present practice on future practice. And present practice is sure to have a powerful influence on the young people who are to be the future farmers and on the quality of soil, farm machinery, and domestic animals with which these young people will have to do when they take charge of the farms. The special winter courses, then, are an important and legitimate feature of agricultural instruction, capable of giving a strong uplift to present agricultural conditions.

And, finally, there are the summer schools for teachers and the one-year and two-year normal courses, in all of which nature study and elementary agriculture are important features. At least eight colleges have organized courses of this kind, and have found teachers prompt and eager to take advantage of the opportunities thus afforded them for preparing to bring the children committed to their charge into more intimate and sympathetic relations with their natural environment. Some of the States now require that instruction in the elements of agriculture be given in the public schools, and the agricultural colleges in those States are aiding to prepare the teachers for this work. More work of this kind needs to be done in order that country children may learn to know and appreciate the beauties and advantages of rural life, and that city children may be enabled to make use of their more limited opportunities for the employment of trees, shrubs, flowers, and other nature material in making the city more wholesome and beautiful, and may have their attention turned to the advantages and opportunities of rural life.

SUMMER SCHOOLS.

Increasing attention is given on the part of the agricultural colleges to the holding of summer schools, one purpose of which is to prepare teachers for giving instruction in nature study and elementary agriculture in the common schools. During the summer the Connecticut Agricultural College has held a summer school for teachers, having an enrollment of over 60; the North Carolina College of Agriculture and Mechanic Arts a summer school, with an enrollment of 361 teachers, 140 of whom took work in agriculture and nature study; the University of Nebraska a summer school, with an enrollment of 45 teachers; the University of Tennessee a summer school, in which 180 teachers took work in agriculture, horticulture, and nature study, and the Hampton (Va.) Normal and Agricultural Institute a summer school, with an enrollment of nearly 500 teachers, all of whom took instruction in either nature study or agriculture. The interest in work of this kind is especially strong in the South at this time, as is shown by the large enrollment of teachers in the southern institutions.

The University of California holds annually a summer session, in which the College of Agriculture offers several courses. In 1903 courses were given in amateur horticulture, entomology, and human foods.

Among the courses annually offered at the summer session of the University of Missouri is one in agriculture for teachers, with special reference to nature study and agriculture in the public schools.

SECONDARY COURSES.

Following the lead of the successful secondary schools of agriculture in connection with the agricultural colleges in Minnesota and Nebraska, similar schools having a two-year course of high-school grade have been organized at the colleges in Maine, Rhode Island, and Oklahoma, and in Washington a three-year course is given.

The Connecticut Agricultural College has done practically the same thing by providing a special group of studies for students coming from the common schools. At the New Mexico Agricultural College agriculture is now successfully taught in the preparatory department. By these means the colleges are not only differentiating secondary instruction in agriculture from the instruction of collegiate grade, but are also aiding the movement for the establishment of separate agricultural high schools. Their work in formulating and successfully putting into operation definite secondary courses in agriculture is therefore of much general importance as a factor in broadening the scope of agricultural education in this country.

THE SECONDARY SCHOOLS.

The attendance at the two county agricultural high schools opened in Wisconsin in the fall of 1902 at Menominee (Pl. LI) and Wausau (Pl. LII), and described in the report of this Office for that year, was large, and the interest manifested in these schools was so great that the State legislature at its last session, recognizing the demand for instruction of this grade, made provision for additional county agricultural high schools with State aid.

The California Polytechnic School (Pl. LIII), located at San Luis Obispo, was opened October 1, 1903. This is a State institution established under an act of the legislature passed March 8, 1901, to take effect January 1, 1902. As stated in this act, "the purpose of the school is to furnish to young people of both sexes mental and manual training in the arts and sciences, including agriculture, mechanics, engineering, business methods, domestic economy, and such other branches as will fit the students for the nonprofessional walks of life."

On making a careful survey of the educational institutions of the State, the trustees found that the greatest need was for a secondary school, giving boys and girls "a training in the arts and sciences which deal peculiarly with country life—the life of the home, the farm, the orchard, the dairy, and the shop." Agriculture, domestic science, and mechanics were therefore made the main lines of instruction in this school. A farm of 280 acres was purchased and on this two principal buildings have been erected.

The recitation and administration building is 47 by 100 feet, with a stone foundation reaching to the first floor.

The remainder of the structure is of wood, covered with a metal lath and cement. The roofing is of metal tile. The basement contains a temporary dairy room, a temporary carpenter shop, storage rooms, and a general lavatory for boys. The first floor contains the director's offices, library, lecture room and laboratory for chemistry and physics, lecture room and laboratory for botany and entomology, photographic dark room, and girls' cloakroom and lavatory. The second floor contains an assembly room, with dressing room, two drawing rooms, and two class rooms.

The dormitory is constructed in the same manner as the recitation building, except that the basement and foundation walls are entirely of concrete. Its dimensions are 40 by 100 feet. Its purpose is to provide a home on the school grounds for a few of the teaching staff and for as many students as can be accommodated. It contains 30 single rooms (each with a closet), a parlor, dining room, kitchen, laundry, and 5 bathrooms. Provision is made for one student in a room.

The land of the farm is rolling and typical of a large section of the coast counties.

The soil is varied in character, comprising rich, black bottoms, adobe, loams, and the rocky soil of the steep hillside. The farm is traversed by Brissolero Creek, the full rights to which are deeded to the school, and from which water may be used for irrigation purposes. On the hillside, a half mile to the east and 350 feet above the school buildings, are two springs which furnish pure water for domestic use.

The farm is in a thermal belt which is so free from frost that citrus fruits can be grown. A small orchard now on the farm contains bearing trees of apples, pears, quinces, peaches, almonds, plums, prunes, cherries, oranges, limes, and grapes. Though the number be few, they prove that all the fruits named will thrive on the school farm. The larger portion of the farm has been cultivated for many years in the production of hay and grain. Some portions are much depleted in fertility and will furnish good experimental ground in demonstrating how such soil may be brought back to its former productiveness.

The farm will be stocked with dairy and beef cattle, swine, and poultry, and a number of farm buildings will be erected.

Students are admitted at the age of 15 years and must have had previous training equivalent to the usual grammar school course. The course of study covers a period of three years. Tuition is free. The cost of books, supplies, and laboratory fees will be about \$35 a year, and room and board from \$20 to \$25 per month.

The school is under the management of a board of seven trustees, including the governor and superintendent of public instruction as members *ex officio*. Prof. Leroy Anderson, formerly instructor in the college of agriculture of the University of California, is at the head of the faculty with the title of director.

Regarding the first session of this school, Professor Anderson, under date of November 30, 1903, writes as follows:

Our school opened on October 1 with 15 students, representing 6 of the coast counties of California. Their ages range from 15 to 20 and they average in age as old as freshmen in our universities. Of the number, 11 are boys and 4 are girls. The work which the boys are taking consists of English, commercial arithmetic, algebra, chemistry, botany, and physical geography. The botany deals largely with the two main topics of how plants feed and how plants grow. The physical geography deals largely with soils, their formation, character, and constituents. Considerable attention is also given to meteorology, with a detailed study of the weather bureau system. The other work of the boys consists of free-hand and mechanical drawing and carpentry.

The girls are taking special work. The academic work consists of English and botany only. They also have free-hand drawing and sloyd. At least half of their time is given to sewing and household economics. The latter half of the year they will take instruction in cooking.



FIG. 1.—AGRICULTURAL EDUCATION—DUNN COUNTY (WIS.) SCHOOL OF AGRICULTURE,
STUDENTS PRUNING FRUIT TREES.



FIG. 2.—AGRICULTURAL EDUCATION—DUNN COUNTY (WIS.) SCHOOL OF AGRICULTURE,
STUDENTS TAKING NOTES ON FIELD CROPS.



FIG. 1.—AGRICULTURAL EDUCATION—MARATHON COUNTY (WIS.) SCHOOL OF AGRICULTURE, SEWING ROOM.



FIG. 2.—AGRICULTURAL EDUCATION—MARATHON COUNTY (WIS.) SCHOOL OF AGRICULTURE, CARPENTER SHOP.



AGRICULTURAL EDUCATION—CALIFORNIA POLYTECHNIC SCHOOL, RECITATION AND ADMINISTRATION BUILDING ON LEFT, DORMITORY ON RIGHT.

An agricultural school of secondary grade has recently been opened at Rutherford, Napa County, Cal., under the auspices of the Youth's Directory of San Francisco, a Roman Catholic organization. For a number of years this organization has been sending boys who had graduated from the grammar grades of its city school to ranches in different parts of the State, but with unsatisfactory results. A ranch of 1,000 acres has therefore been purchased, on which vineyards and orchards are being planted, and stock raising and dairying are being established with the aid of the students sent from the city schools. A building with class-room laboratories and dormitories to accommodate 150 boys is now being erected.

The Mount Hermon School, near Northfield, Mass., founded by the late D. L. Moody, has established an agricultural department, and now offers courses of instruction in that subject. This step on the part of one of the largest secondary schools in the United States will be a matter of interest to those who are following the progress of secondary agricultural education. It is the more significant from the fact that the institution is not a technical school, and that this is the first attempt to establish an industrial course. It is another indication of the hold which this grade of agricultural education is taking.

The school has for some time had a farm of about 1,000 acres, which is carried on quite largely with student labor. In consideration of the low rate of tuition and board, pupils are expected to work about fifteen hours a week, and many of the boys have put in this time on the farm. As now operated it is said to yield a good profit. Much of the product finds a market at the boys' and girls' departments of the school and the Bible school, which together have an aggregate of about 900 students. There is at present a dairy of about 200 cows, and fruit orchards of considerable proportions, together with a cannery for putting up vegetables, especially tomatoes, peas, and corn.

There has, however, been no theoretical instruction in agriculture or horticulture. Mr. Harry Hayward, a graduate of the school and for several months past assistant chief of the Dairy Division of this Department, has now been called to the school as director of the agricultural department, and entered upon his duties August 1. The department will be organized into divisions for horticulture, dairying, and field work; and courses will be offered in different branches of agriculture, which it is understood will be mainly elective. In other words, only such of the 425 boys in the school as are especially interested in agriculture will be required to take the courses, although others may be required to work on the farm as heretofore.

It is planned to carry the farm on with student labor to even a greater extent than in the past, with practical foremen at the head of the several departments. As the school runs practically the year round, there being three terms of sixteen weeks each, this plan will be feasible.

An effort will be made to make the instruction as practical as experience and the conditions surrounding the school will permit. A considerable number of the pupils come from the farming districts and expect to return to the farm, and the courses will be planned with special reference to their needs. With the equipment already at hand the opportunity would seem to be an unusual one for demonstrating the high value of agricultural courses in secondary schools.

In Massachusetts arrangements are being made to carry into effect the provisions in the will of Oliver Smith, which call for the establishment of an agricultural school. Mr. Smith was born at Hatfield, Mass., in 1776, and died in the same town in 1845, having amassed a fortune then valued at \$370,000. By will he provided for a number of charitable enterprises which have since been wisely administered by a board of trustees, and in such a manner that the funds have grown until they reach a total of over one and one-third million dollars. The provisions of Mr. Smith's will relating to the agricultural school do not permit of its establishment before December 22, 1905, at which time the fund available for this purpose will be \$300,000 or more. The founder directs that this school shall be established in the city of Northampton, Mass., and shall have in connection therewith "a pattern farm" and an experimental farm. Since the Massachusetts Agricultural College is located at Amherst, only 8 miles from Northampton, it is very probable that the new school will be of secondary grade and will be closely affiliated with the college.

The first annual report of the Winona Agricultural and Technical Institute at Winona Lake, Ind., founded in 1902, shows that 92 boys were enrolled during its first session, of whom 57 came from the city, 21 from villages, and 14 from farms, and ranged in age from 14 to 22.

This school is founded upon the assumption that boys should begin early to assume a part of the responsibility for their education. To that end all students are required to work on an average fifteen hours per week, which partially pays their expenses. The labor of each boy is valued at 8½ cents per hour.

Two hundred and twenty-five dollars will pay for board, room, heat, light, and tuition for the year—thirty-six weeks. This amount will be decreased at the rate of 8½ cents for each hour of labor performed by the boy.

The course of study covers two years in a preparatory department corresponding to the seventh and eighth grades of the public schools, and four years in an academic department, in which the studies will be grouped in four courses entitled agriculture, trades, elementary technology, and academic. The course in agriculture will begin in the second year of the preparatory department and run through the four years of the academic department, provision being made in the last year for electives.

A substantial brick building, known as the Mount Memorial Building, has been erected for the school work, and there are also two

dormitories. The school is under the management of a board of 21 directors and a faculty of 13 members.

In Elyria, Ohio, a city of about 10,000 inhabitants, Mr. Lyman Carrier, a graduate of the Michigan Agricultural College, has recently been appointed teacher of sciences in the public high school, and an elective course has been arranged in which agriculture is to be taught in the third and fourth years. A class of 7 boys, all sons of farmers, elected this course the present school year. Instruction in animal husbandry, with special reference to dairy animals, is being given by lectures, laboratory exercises, visits to farms, etc. Later on soils and farm crops will be taken up. Of the 327 students in the Elyria High School this year, 103 are from the country. This work is being watched with great interest, since in Ohio and in many other States are high schools containing large numbers of country boys to whom such courses, if successful, will appeal.

THE PRIMARY SCHOOLS.

The movement for the introduction of the teaching of agricultural subjects into the primary schools made considerable progress during the past year. This matter is being widely discussed in assemblies of teachers and farmers and in the press. But better and more effective than this are the actual trials of such instruction in the schools, which are now going on in a number of places in different parts of the country. The State legislatures are being affected by this movement and already laws have been passed in a number of States by which instruction in agriculture in the public schools is permitted or encouraged. Such laws now exist in Alabama, Florida, Georgia, Illinois, Louisiana, Maryland, Michigan, Missouri, North Carolina, and Wisconsin.

The State superintendents of public instruction are beginning to take an active interest in this subject. Definite provision is made for elementary courses in agriculture in the general courses of study outlined for the public schools in Illinois and Missouri. In Illinois this course has been prepared by Prof. Eugene Davenport, dean of the College of Agriculture of the University of Illinois, and includes outlines and suggestions for a series of simple observations and experiments on a variety of topics connected with the growth of cultivated plants and with animal husbandry, arranged according to the months of the school year and the vacation period.

In New Hampshire a similar course has been prepared by Prof. G. H. Whitcher, superintendent of schools for several towns, and recently president of the State Teachers' Association.

Provision has been made for the training of teachers in agricultural subjects in the three State normal schools of Missouri, in county train-

ing schools in Wisconsin and Michigan, and in summer schools or special courses connected with agricultural colleges in California, Connecticut, Missouri, New York, North Carolina, Tennessee, and Virginia.

A very interesting work is being done by Mr. O. J. Kern, superintendent of schools for Winnebago County, Ill. Every effort is being made to secure the general improvement of the schools of this county by increasing the efficiency of the teaching force, consolidating the weak schools, improving the school buildings and their equipment, beautifying the school grounds, and securing useful district and traveling libraries. But in addition to this the teaching of agriculture is being directly promoted in a number of ways. Through meetings and publications the teachers and the patrons of the schools are being shown the usefulness and the practicability of teaching agricultural subjects in the rural schools. The illustrated publications entitled "The Country School and the Country Child" and the "Winnebagoes" bring out very clearly the features and progress of this work. The school garden is being made a strong feature of the work at present, and, in 1903, 70 district schools in this county report that they have grown plants of some kind. In order to interest the farm boy and his parents in this new movement for the betterment of the country schools, Superintendent Kern organized a Farmer Boys' Experiment Club. This was begun February 22, 1902, with a membership of 37 boys, and has grown until in November, 1903, it had 405 members. The college of agriculture of the University of Illinois is cooperating in this work. The work of the club is thus described by Superintendent Kern:

The machinery of the organization is very simple. There is no elaborate constitution and by-laws to set forth in high-sounding terms what the boys are on earth for. The county superintendent has a list of the names of the boys, with the post-office address of each. Superintendent Rankin, of the agricultural college extension work, has a duplicate list, and from each office go circulars, bulletins, and literature of various kinds, the main object being to keep in touch with the boys and to interest them more deeply in the beauty of country life and the worth, dignity, and scientific advancement in agriculture.

After the organization of the club it occurred to me that it would do a great deal of good to have the boys and their parents go on an excursion to the agricultural college and experiment station connected with the University of Illinois at Urbana. Rockford is 214 miles from Urbana, and we secured a rate of \$2.50 for the round trip. On June 5, 1902, 130 boys and 150 adults—nearly six coaches full—left Rockford for Urbana, and on June 1, 1903, a second excursion, numbering 204 persons, was run to the same place. Only 13 persons of the second excursion were members of the first. The expectation is, if proper arrangements can be made, to continue these excursions to the colleges of neighboring States. We hope to arrange for an excursion to the St. Louis Exposition in 1904.

While at the college of agriculture and experiment stations, the boys were shown the laboratories where the work of testing and improving types of corn, treatment and analysis of soils, propagation of plants, etc., was done. On the experiment farm

the boys were shown the growing crops and were told how they were being cared for and what experimental work was being done. They inspected sugar beets, oats, corn, soy beans, cowpeas, wheat, and alfalfa. Some roots of the last-named plant were pulled up and the boys were shown where the bacteria deposit in the ground the nitrogen which they take from the air.

The live-stock department of the farm appealed strongly to the boys. They inspected a model dairy barn. At the feeding yards they saw a bunch of steers that were being fed a balanced ration that would make it possible for the cattle to bring the top price in the Chicago market. The horticultural department was of more than passing interest.

To be sure, it is too soon to say what the effect of these excursions will be. Some of the boys had never been on a railroad train. Many more had never been out of the county. We will wait patiently for time to show results in quickened aspirations, stronger characters in growing boys, and a general uplift in the educational interests of Winnebago County.

The experimental and observation work of the boys thus far has consisted in testing vitality of various seeds, planting corn and noting growth, testing for smut in oats, experimenting with sugar beets, etc.

In making investigations with reference to smut in oats, each boy was directed to go into four different fields and make three counts in the same field by placing a barrel hoop over as many stalks of grain as the hoop might inclose, and then counting and recording results. The percentage of smut was determined by the boys. Some of the work that came under my personal direction showed a percentage of smut from 3 per cent, the lowest, to 23 per cent, the highest. This was practical work in arithmetic.

Each boy last year was given 2 pounds of sugar-beet seed by the experiment station at Urbana. The department wanted to interest the boys and see at the same time whether sugar beets could be grown with profit in this dairy region of northern Illinois. Some very fine beets were raised by the boys. They selected specimens and sent them to the experiment station to be analyzed. The remainder were fed to the stock on the farm.

The boys concluded that, if sufficient help could be secured at a reasonable wage, sugar beets could be grown here with profit. One boy kept an exact account of labor, rent of ground, etc.—in short, the first cost of raising his beets. His plat comprised 45 square rods of ground. The total cost of cultivation, harvesting, and rent of ground was \$19.75. The number of bushels raised was 183, thus making the cost a trifle over 10 cents per bushel. These beets were tested, the best of those received at the experiment station showing 18 per cent sugar and 86.7 purity coefficient. This was practical work for the boys, and many of them have notebooks on the present year's work.

At present, in Illinois the breeding of improved types of corn is attracting the attention of the farmers. Professor Hopkins, of the Illinois College of Agriculture, is able to show results from experiments over a number of years that corn may be bred to produce a high percentage of oil, thus making it more valuable commercially, or it may be bred to produce a high percentage of protein, making it more valuable for feeding purposes. The Illinois State Farmers' Institute gave to every boy of Winnebago County who sent 4 cents in postage 500 grains of this high-bred corn. Nearly 200 boys of the experiment club sent for the corn last spring and planted it. Each boy is expected to note all interesting facts about the growth of the corn and make an exhibit of the 10 best ears at the county farmers' institute next January and enter in competition for prizes already offered by the officers of the institute. This is practical work to get them interested in approved types of grains and in touch with that great educational movement, the farmers' institute.

The boys also make observations as to barren stalks of corn in plats 100 hills square and compute the percentage. The time the tassel and silk appear on a stalk of corn is noted. It is not expected that a 10-year-old boy be equipped with a compound microscope of 10,000 diameters and have him know the whole mystery of life from the study of a cross section of a grain of pollen, and that at a single sitting. Nay; rather have him use his eyes—a little observation this week, more next week, more next year—until the habit of observing is fixed and silently there grows within him the power to judge and he becomes educated because he sees things with his eyes.

During the past summer the boys have held meetings at various farms. * * *

Last winter during the annual meeting of the county farmers' institute a half-day session was devoted to the interests of the boys. Several members of the experiment club gave an account of their work; some of the fathers suggested how they might help along the work of the club, while a few teachers told how the district school might assist such an organization of boys. * * *

We are arranging a monthly lecture course for the Boys' Experiment Club, the Girls' Home Culture Club—now being organized, and the parents of Winnebago County during the coming fall and winter months on one Saturday of each month. This is made possible by a small appropriation from the county board of supervisors toward the expense of securing speakers. The deficit will be made up somehow. The lectures are all free and held in the beautiful auditorium of the new Memorial Hall erected by the people to the memory of the soldiers and sailors of Winnebago County, and dedicated by President Roosevelt last June.

The course, so far, includes:

October: Corn Growing, by Professor Holden, Iowa College of Agriculture.

November: Stock Feeding, Dean Henry, Wisconsin College of Agriculture.

December: The Kind of School for Country People, by Dean Davenport, of the Illinois College of Agriculture.

The remaining numbers will be provided for. It is the expectation to close the course in February with a lecture on the Value of Birds to the Farmer, illustrated with a stereopticon.

A similar club for boys and girls has been formed in Ohio, under the auspices of the Agricultural Students' Union of the Ohio State University, and a number of clubs have lately been formed in Iowa.

THE SCHOOL GARDENS.

The nature and extent of the school-garden movement in this country have already been presented in another place in this report (see pp. 573-584.)

ELEMENTARY BOOKS FOR SCHOOLS.

Until quite recently one of the greatest hindrances to effective work on behalf of the introduction of school gardens and elementary courses in agriculture has been the lack of suitable text-books, manuals, and reference books. This difficulty is now being rapidly overcome, and especially during the past year a number of useful books in these lines have been published. Mr. D. J. Crosby, of the Office of Experiment Stations, recently made a list of some of these books which are useful to teachers and scholars, and this was published as Circular No.

52 of this Office. Since it illustrates an important step in the progress of the movement on behalf of agricultural education, it is given herewith. (See also Development of the Text-book of Agriculture in North America, p. 689).

The following list of publications is not comprehensive; it is purposely very much abridged. It has not been the aim to list all the good works published on nature study, school gardening, and elementary agriculture. Such a list would be so long as to be confusing to both teacher and pupil. The aim has been rather to suggest a few (1) books which would aid the teacher just beginning nature-study work to get the proper point of view, (2) supplementary aids for the teacher, (3) interesting nature stories for pupils, (4) up-to-date elementary texts on agriculture, suitable for pupils in the last two years of the grammar school and the first two years of the high school, and (5) publications which might serve as the nucleus for a public-school agricultural library.

NATURE STUDY AND SCHOOL GARDENING.

BOOKS FOR TEACHERS.

- Bailey, L. H. *The Nature-Study Idea* (New York: Doubleday, Page & Co., 1903, pp. 159, figs. 2).
 Goff, E. S. *Principles of Plant Culture* (Madison: E. S. Goff, 1897, pp. 276, figs. 173).
 Hemenway, H. D. *How to make School Gardens* (New York: Doubleday, Page & Co., 1903, pp. XVI+107, pls. 8, figs. 16).
 Hodge, C. F. *Nature Study and Life* (London and Boston: Ginn & Co., 1902, pp. 514, pl. 1, figs. 196).
 Jackman, W. S. *Field Work in Nature Study* (Chicago: A. Flanagan Co., 1894, pp. IV+129, il.).

SUPPLEMENTARY READING FOR TEACHERS.

- Bulletins and Leaflets on Nature Study and School Gardening published by—
 New Hampshire College of Agriculture and Mechanic Arts, Durham, N. H.
 Cornell University, Ithaca, N. Y.
 State Department of Agriculture, Harrisburg, Pa.
 Rhode Island College of Agriculture and Mechanic Arts, Kingston, R. I.
 Hampton Normal and Agricultural Institute, Hampton, Va.
 Farmers' Bulletins published by the U. S. Department of Agriculture, Washington, D. C.:
 No. 42. *Facts About Milk.* Pp. 29.
 No. 54. *Some Common Birds.* Pp. 40.
 No. 86. *Thirty Poisonous Plants.* Pp. 32.
 No. 93. *Sugar as Food.* Pp. 27.
 No. 95. *Good Roads for Farmers.* Pp. 47.
 No. 99. *Insect Enemies of Shade Trees.* Pp. 30.
 No. 111. *The Farmer's Interest in Good Seed.* Pp. 24.
 No. 127. *Important Insecticides.* Pp. 42.
 No. 128. *Eggs and Their Uses as Foods.* Pp. 32.
 No. 134. *Tree Planting in Rural School Grounds.* Pp. 32.
 No. 154. *The Fruit Garden: Preparation and Care.* Pp. 20.
 No. 155. *How Insects Affect Health in Rural Districts.* Pp. 20.
 No. 157. *The Propagation of Plants.* Pp. 24.
 No. 173. *Primer of Forestry.* Pp. 48.

SUPPLEMENTARY READING FOR PUPILS.

- Burroughs, John. Works (Boston and New York: Houghton, Mifflin & Co., 11 vols.).
- Burroughs, John. A Year in the Fields (Boston and New York: Houghton, Mifflin & Co., 1901, pp. XIV+220, pls. 24).
- Harrington, M. W. About the Weather (New York: D. Appleton & Co., 1899, pp. 246, il.).
- Seton, Ernest Thompson. Lives of the Hunted (New York: Charles Scribners' Sons, 1901, pp. 360, il.).
- Seton, Ernest Thompson. Wild Animals I Have Known (New York: Charles Scribners' Sons, 1898, pp. 358, il.).

Leaflets:

- Blair, J. C. The Study of Horticulture.
- Davenport, E. The Study of Farm Animals.
- Davenport, E. The Study of Agriculture.
- Shamel, A. D. The Study of Farm Crops.
- (Taylorville, Ill.: C. M. Parker, 1901-1903.)

ELEMENTARY AGRICULTURE.

TEXT-BOOKS.

For the Seventh and Eighth Grades:

- Bessey, C. E., et al. New Elementary Agriculture (Lincoln, Nebr.: The University Publishing Co., 1903, pp. X+194, figs. 62).
- Burkett, C. W., et al. Agriculture for Beginners (London and Boston: Ginn & Co., 1903, pp. XII+267, figs. 215 and frontispiece).
- James, C. C. Practical Agriculture (American edition edited by John Craig. New York: D. Appleton & Co., 1902, pp. VIII+203, pls. 11, figs. 90).

For the Ninth and Tenth Grades:

- Bailey, L. H. Principles of Agriculture (New York and London: The Macmillan Co., 1898, pp. XVI+300, figs. 92).
- Brooks, W. P. Agriculture (Springfield, Mass.: The Home Correspondence School, 1901, vol. 1, pp. XVII+199, figs. 55, map 1; vol. 2, pp. XXIV+201-541, figs. 119, map 1; vol. 3, pp. XX1+543-855, figs. 122).

BOOKS AND BULLETINS FOR REFERENCE.

- Bailey, L. H. The Garden-Craft Series. (New York: The Macmillan Co.)
- The Horticulturist's Rule-Book.
- Plant-Breeding.
- The Forcing-Book.
- The Nursery-Book.
- Garden-Making. Suggestions for the Utilization of Home Grounds.
- The Pruning-Book.
- The Practical Garden Book.
- Bailey, L. H. (Editor.) The Rural Science Series. (New York: The Macmillan Co.)
- Bailey, Principles of Agriculture.
- Bailey, Principles of Fruit-Growing.
- Bailey, Principles of Vegetable-Gardening.
- Card, Bush-Fruits.
- Fairchild, Rural Wealth and Welfare.
- Jordan, Feeding of Animals.
- King, The Soil.

Bailey, L. H. (Editor)—Continued.

King, Irrigation and Drainage.

Lodeman, The Spraying of Plants.

Roberts, The Fertility of the Land.

Roberts, The Farmers' Business Handbook.

Roberts, The Farmstead.

Voorhees, Fertilizers.

Watson, Farm and Poultry.

Wing, Milk and Its Products.

Bailey, L. H. *Lessons with Plants* (New York: The Macmillan Co., 1899, pp. 491, figs. 446).

Conn, H. W. *Agricultural Bacteriology* (Philadelphia: P. Blakiston's Sons & Co., 1901, pp. 412, figs. 40).

Craig, John A. *Judging Live Stock* (Ames, Iowa: Published by the Author, 1901, pp. 193, il.).

Decker, J. W. *Cheddar Cheese Making* (Madison, Wis.: Published by the Author, 1895, pp. 151, il.).

Decker, J. W. *Elements of Dairying* (Columbus, O.: Published by the Author, 1903, pp. 114, il.).

Gurler, H. B. *American Dairying* (Chicago: Breeder's Gazette Print, 1894, pp. 267, il.).

Hampton Agricultural Leaflets (Hampton, Va.: Hampton Institute Press).

Hampton Animal Industry Leaflets (Hampton, Va.: Hampton Institute Press).

Hays, W. M., et al. *Rural School Agriculture Bulletin I* (St. Anthony Park, Minn., Department of Agriculture, University of Minnesota).

Howard, W. L. *Plant Propagation—Some Phases of Practical Horticulture Adapted to Use in the Public Schools* (Columbia, Mo.: Agricultural Experiment Station, Circular of Information No. 13, 1902, pp. 50, figs. 20).

King, F. H. *Text-Book of the Physics of Agriculture* (Madison, Wis.: Published by the Author, 1901, pp. 604, il.).

Mumford, F. B. *The Principles of Plant Production—The Seed* (Columbia, Mo.: Agricultural Experiment Station, Circular of Information No. 15, 1903, pp. 38, figs. 11).

Snyder, Harry. *Chemistry of Dairying* (Easton, Pa.: Press of the Chemical Pub. Co., 1897, pp. 156).

Snyder, Harry. *Chemistry of Plant and Animal Life* (Easton, Pa.: Press of the Chemical Pub. Co., 1903, pp. XVII+406, il.).

Snyder, Harry. *Chemistry of Soils and Fertilizers* (Easton, Pa.: Press of the Chemical Pub. Co., 1899, pp. 277, il.).

Van Slyke, L. L. *Modern Dairy Science and Practice* (Harrisburg, Pa.: Department of Agriculture Bulletin 104, 1902, pp. 127, il.).

Voorhees, E. B. *First Principles of Agriculture* (New York: Silver, Burdett & Co., 1896, pp. 212).

Wallace, R. H. *Agriculture* (Philadelphia: J. B. Lippincott Co., 1895, pp. 352, figs. 136).

Weed, C. M. *Fungi and Fungicides* (New York: O. Judd Co., 1894, pp. 228).

Weed, C. M. *Spraying Crops: Why, When, and How* (New York: O. Judd Co., 1903, 4. ed., pp. XI+136, il.).

Whitcher, Geo. H. *An Outline Course in Agriculture for Public Schools* (Durham, N. H.: Published by the Author, 1903, pp. 12).

Woll, F. W., et al. *Handbook for Farmers and Dairymen* (New York: John Wiley & Sons, 1900, 2. ed., pp. 437).

Course of Study for the Common Schools of Illinois—Third General Revision (Taylorville, Ill.: C. M. Parker, 1903, pp. 219).

Course of Study for Rural and Village Schools (Jefferson City, Mo.: State Department of Education, 1903, pp. 32).

Experiment Station Work (Subseries of Farmers' Bulletins, U. S. Department of Agriculture, Washington, D. C.).

Farmers' Bulletins (U. S. Department of Agriculture, Washington, D. C.).

Select bulletins wanted from complete list.

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FARMERS' INSTITUTES IN THE UNITED STATES.

By JOHN HAMILTON,

Farmers' Institute Specialist, Office of Experiment Stations.

The demand for exact information of a kind to be of assistance to the practical farmer has resulted in the establishing of farmers' institutes. The work has developed so rapidly and has reached such proportions as to now be organized in almost all of the States and Territories, and has attracted the attention of all who are interested in the effort to improve agricultural conditions in the United States. No common or uniform system has been adopted by the States, but each is conducting its work for the most part according to methods inaugurated when the movement first began, and when there had been but little experience to guide in their constitution.

The formation of the American Association of Farmers' Institute Workers was the first attempt to secure uniformity. Through the influence of this association the directors of institutes have had brought to their attention the varying degrees of success that have been secured from the use of different methods, with the result that the most successful are being generally adopted and thereby a greater degree of uniformity is being secured. The action of the National Department of Agriculture in taking up this work in a systematic way through the appointment of a special officer to give his entire attention to aiding in its development promises to be of service in this direction. The fact that there is a central office to which application can be made for information respecting institutes, and where statistical data can be gathered for the benefit of the State directors and institute lecturers, will do much to bring about a closer union of the workers and greater uniformity in their methods. During the few months in which this office has been in existence, the farmers' institute specialist has perfected the list of State directors, and has secured a considerable amount of statistical information that shows approximately the condition of the institutes throughout the country. Expressions of interest in what the Department is undertaking in aid of this work and many offers of cooperation have been received from the State directors and institute lecturers.

As a matter of record it may be well to state that Congress, at the request of the Secretary of Agriculture, provided at its last session

for the appointment of a farmers' institute specialist in the Office of Experiment Stations in the Department of Agriculture, and appropriated the sum of \$5,000 for the purpose of meeting the necessary expenses. The duties of this officer, as stated in the act making the appropriation, are "to investigate and report upon the organization and progress of farmers' institutes in the several States and Territories, and upon similar organizations in foreign countries, with special suggestions of plans and methods for making such organizations more effective for the dissemination of the results of the work of the Department of Agriculture and the experiment stations and of improved methods of agricultural practice." The institute specialist entered upon his duties on the 1st of April, 1903.

Inasmuch as there has been no precedent to be followed or plan formulated, it was necessary first of all to define the character and outline the scope of the work that the institute officer should undertake. It was manifest that the relation of the Department to the institute work in the several States must of necessity be largely advisory and in the way of securing and sending out to the State authorities information respecting the condition and progress of the work throughout the country.

It was agreed that every effort should be made to strengthen the work in each State by aiding in perfecting their institute organizations and by assisting in improving and increasing their lecture force, and that the channels through which the Department ought to operate should be those which each State has created for the management and control of the institute work within its limits.

As soon as this had been settled the work of securing definite information in regard to the condition of the farmers' institutes in the several States was taken up. Requests were sent out to the State directors asking for copies of the laws under which the institutes are organized and operated in their States, and also for information as to the amount of money available for institute purposes for the year ended June 30, 1903, as well as for that ending June 30, 1904. There was general response to these inquiries, and copies of the laws have been secured and arranged for publication.

A comparison of the laws and of the reports of the superintendents in States in which institutes exist shows that the control of the work throughout the country is by no means uniform. In 21 States and Territories the management is in the hands of the State boards of agriculture or boards of similar character. In 21 States and Territories it is in the hands of the agricultural college or experiment station officers, and in 5 others the control is vested in special boards constituted for the purpose.

In a number of States the local institutes are organized under laws which specify their duties and prescribe their form of organization.

In such States, therefore, the local institute organizations are permanent in their character and are obliged to report annually to the State superintendent, showing that they have complied with the laws constituting them, before they can receive any appropriation for their support. In a few States no local boards of institute officers exist, but the State director selects from year to year a correspondent in each county, and to these correspondents the work of advertising the meetings, selecting local committees, renting halls, and other preliminary arrangements is committed. All of the directors recognize the need for some form of local assistance to relieve them of minor details, and the tendency is in the direction of legally constituted county societies, or institutes, to take charge of the purely local work, leaving to the State officers that of providing for the districting of the State into sections, fixing dates of institutes in the several sections, and of supplying to each a corps of speakers selected and paid by the State director to assist in conducting the institutes.

Fourteen States held annual round-up institutes last year. In some instances these meetings were confined to the lecture force. In others the local directors of institutes were also included, while others included in the round-up meeting lecturers, local managers, and the general farming public. In all cases the directors have found that these annual meetings of the workers for conference have been highly advantageous in creating enthusiasm and in securing greater uniformity of method among those who are intrusted with the organization and conduct of the work. Prominent lecturers and specialists from other States are frequently invited to these meetings, who present new methods, found to be successful elsewhere, for the consideration of their hearers.

NATIONAL MEETING OF INSTITUTE WORKERS.

A meeting in many respects similar to the State round-up was held in June, 1903, by the American Association of Farmers' Institute Workers, at Toronto, Canada. Seventeen States of the Union were represented by delegates, and several of the Provinces of the Dominion of Canada. A full stenographic record of the proceedings was made and has been published as Bulletin No. 138 of this Office. One of the most important subjects brought before that meeting was that of interesting the sons and daughters of farmers in the institute work. Facts were presented showing that it is possible to interest the boys and girls of the country in agriculture so as to secure their attendance at the institute meetings, and that it is also possible to induce many of them to enter upon a course of study suited to fit them to enter the agricultural college of their State. This feature of the institute ought to be carefully considered and some method devised that can be generally adopted which will create in the minds of young people a desire for

and a better appreciation and knowledge of farm operations, and that will lead them to the agricultural college for the information which they need. One means that has been found effective in securing the results indicated is that of prescribing some simple experiments in the growing of crops, to be conducted by country children, upon which each is to report to a subsequent institute and submit also a sample of the product in competition for some prize or other award in recognition of its merits. The close attention demanded by the care of a growing crop during the season develops powers of observation that become more discriminating and acute each year, and leads eventually to the desire for and the careful study of literature which explains the scientific phenomena involved in the operations which they have conducted. The principle which this method of developing interest involves is capable of application in a great variety of ways, and is the lever that must be used if the children of farmers are to be lifted out of the monotony and drudgery of the old farm routine.

INTEREST INCREASING.

The interest manifested in the farmers' institutes is seen in the action of the legislatures of the several States and of the officers having control of the work in making appropriations for their support. Amounts varying from \$35 in the Territory of Hawaii to \$20,000 in the State of New York show the extremes, the aggregate for the 45 States and Territories reporting being \$187,226. The appropriations for the coming season, as shown by the reports of 40 States and Territories, amounts to \$210,975. If the States not reporting appropriate sums equal to those of last year, the total for the coming season will reach \$214,729, or \$27,503 more than was appropriated for the year just closed. It may be of interest to know that where the institutes have been longest in operation the appropriations are correspondingly large. New York \$20,000; Pennsylvania \$15,000 for the past season and for the next year \$17,500; Ohio \$16,981; Wisconsin \$12,000; Illinois \$18,150; Indiana \$10,000; Minnesota \$16,500; Michigan \$7,500. Other States with smaller agricultural population have been equally liberal: West Virginia \$5,451; Vermont \$5,000; Maryland \$4,000; Maine \$3,000; Florida \$2,500, and California \$4,000.

Institutes were held in all of the 52 States and Territories excepting 6—3 States and 3 Territories. The attendance has been increased over that of last year, the reports showing 904,654 for this year as against 819,999 for the previous year. The real advance numerically is greater than these figures indicate. The method of computing averages for the attendance was changed this year upon the recommendation of the American Association of Farmers' Institute Workers, with the result of reducing the number reported in the four States of Pennsyl-

vania, Michigan, Idaho, and North Dakota 99,481. That this falling off is not real, but is occasioned by the new method of averaging, is shown by the fact that these 4 States held 126 more institutes this year than last, showing conclusively that the interest is increasing instead of diminishing, as the figures unexplained would indicate. If this correction is made, the attendance for the past year exceeds that of the previous year by 184,136.

The total number of institutes was 3,179. One thousand three hundred and fifty-nine were one-day institutes; 1,637 were two-day, and 77 were three-day and over. A more accurate understanding of the amount of work accomplished is shown by the number of sessions held, which amounted to 9,570 during the year. These meetings were addressed by 924 lecturers employed by the State directors and by about three times as many more employed by the local managers of institutes, making a total approximating 4,000 persons who gave instruction at the institutes during the year. One hundred and ninety-six of these were members of the agricultural college or experiment station staffs, who contributed 1,666 days of time to this work, attending in all 752 institutes.

EXTENSION OF THE WORK.

The agricultural population of the United States was not less than 27,000,000 at the date of the last census. Before this large number of our citizens can be brought in touch with the institute movement, it is manifest that it will be necessary to greatly extend the work and effect an organization that will be compact in its structure and systematic in its operation, having definite plans for coming into contact with every farmer's family and for bringing to these workers in the field of agriculture the precise kind of information which the individual most needs.

The necessity for a greater number of competent lecturers to give instruction in institutes is felt in every State. In response to a circular letter recently sent out to the directors of institutes asking for the names of lecturers who have been in their employ during the previous year on the State lecture force, there have been received something over 850 names. An examination of the reports of 623 lecturers shows that 287 of them had college degrees, 138 had taken partial college courses, 108 had the advantage of normal or high school training, and 90 were practical specialists, having had ordinary educational advantages. Five States each reported over 50 members on their lecture corps; 10 States between 20 and 50; 12 States reported between 10 and 20; 12 States reported between 5 and 10. One State reported but 1, and another large agricultural State only 3. A number of States reported scarcely any names outside of those of persons connected with their agricultural college or experiment station staffs.

It is clear that the first great need is some effective method for increasing the number of teachers capable of giving instruction along the lines of agricultural science. The number of specially educated and carefully trained instructors in agriculture is at present limited. Many of the most competent men graduated by the agricultural colleges each year are being engaged by the colleges and stations for the work of instruction, while others are employed in directing farm operations on a large scale for companies, or on the estates of wealthy capitalists, and are therefore fully occupied with the duties that they have assumed. Their time is thus preempted in a way that makes it impracticable for them to devote any considerable portion of it to the general work of educational extension in the institute field.

It will doubtless be many years before a sufficient number of highly educated and liberally trained scientists can be had to supply the demands of the institute work. On the other hand it might be possible, through the cooperation of the agricultural colleges and experiment stations and the National Department of Agriculture, to equip a large number of practical men along at least one line, or in a single specialty, so as to make them capable teachers in that respect. To do this there should be organized some system by which men who have made a life pursuit of some phase of agricultural practice can be discovered and can be furnished with the latest and best information relating to their specialty. These men should be sought out in every State, their names listed and correspondence opened with the view of interesting them in perfecting their education.

To this end courses of study might be prepared by the agricultural colleges and by this Department under the correspondence system, which would enable these specialists to supplement their practical experience with the scientific training that each needs for the effective presentation of that which he undertakes to teach. It might be well also for the agricultural colleges to consider the practicability of establishing normal courses for farmers' institute instructors which would enable the institute lecturers to attend certain lectures and engage in appropriate studies and courses of reading, not for general culture, but for information along specific lines, permitting each student to select topics relating to his specialty. From time to time the body of students in attendance upon these institute courses could be assembled for general lectures upon the art of teaching and the practical methods of institute work. Examinations could be required of each student in the specialty which he has selected, and a suitable certificate of proficiency be given by the college which would be of service in securing invitations for institute engagements. This course ought perhaps to extend through several weeks and include a system of laboratory and field practice that would give the students some insight into the methods pursued in research work.

COOPERATIVE EXPERIMENTS FOR INSTITUTE LECTURERS.

The training of men for lecture service can also be assisted by cooperation on the part of the experiment stations. Original research work must always be in the hands and under the control of men of the highest scientific ability, but the verification of results which they have obtained and the demonstration of truths which the stations wish to disseminate could be greatly assisted by availing themselves of careful, practical specialists working under station direction in various localities throughout the State. Such cooperation has been tried in several of the States and in the Province of Ontario, Canada, with results that are convincing as to their value to the State and as to their strengthening influence upon the individuals who have conducted the work.

An instance is given where experimenters numbering 3,845, located in all parts of a province, have recently reported to their experiment station the results of their work for 1903, which was planned and directed by the station officers. Fruits, grains, vegetables, grass crops, and animals have been tested in this way simultaneously upon all soils in many localities and under varying conditions. The results compared and tabulated have been of great value to the citizens of the several districts embraced by these experiments. Inasmuch as this work was begun under the impetus given to inquiry and research by the farmers' institute movement and has been carried into effect by selected citizens who have been identified with the farmers' institute work, it may be of service to quote from a recent report of the work of the Ontario Agricultural and Experimental Union, made by its secretary:

The number of experimenters engaged in the cooperative work has increased from 12 in 1886 to 3,845 in 1903. In agriculture alone there have been 31,051 distinct tests made throughout the province since the work was started 18 years ago. These tests have required about 148,537 separate plats. The increase in the number of experimenters in agriculture can be seen from the following figures, which show the exact numbers actually engaged in the work in each of the several years: 1886, 12; 1887, 60; 1888, 90; 1891, 203; 1892, 754; 1894, 1,440; 1896, 2,425; 1901, 2,760; 1902, 3,135; and 1903, 3,845. In horticulture the cooperative work was taken up by 15 experimenters in 1888 and by about five hundred experimenters in 1903.

The secretary, in a letter of November 19, 1903, in commenting upon this work, states—

That the cooperative experiment work along the various lines of agriculture which is being conducted by the Agricultural and Experimental Union is exerting an influence which is wholesome in its character, extensive in its operation, and far reaching in its results. It deals with the agriculturists themselves, as well as with the materials which are used in agriculture; with living, thinking, active men, as well as with soils, fertilizers, plants, trees, and animals. Its tendencies are to improve men and to help men improve agriculture. It opens up a channel through which some

of the best material of the experiment station can be brought to the homes of ex-students of the agricultural college and of other farmers; it makes direct application of the information gained at the station by having experiments conducted on hundreds and even thousands of farms, and it systematizes the cooperative work in such a way that the results of those experiments, which have been conducted with care and accuracy, can be summarized and made into valuable reports for the guidance of farmers generally. Perhaps the greatest advantage of the cooperative experiment work is that it helps the best farmers to help themselves and to help others. It combines in an admirable way the training of the hands and the training of the intellect, and is one of the greatest educational features which has been introduced throughout the rural districts in recent years.

The beneficial results that have come from this method of educating the farming people are so conspicuous throughout the locality in which it has been tried as to be remarked by all intelligent travelers who visit that section. That research work is the first duty of the experiment station is unquestionably true. It is also true that the carrying of the results to the people who need the information which has been secured is likewise a duty. Whether this shall be accomplished through the dissemination of literature, the sending out of station officers to publish the information before farmers' institutes, the use of intelligent citizens in cooperative experiment work, or all three of these, is a question to be determined by those to whom has been committed the work of experimentation by their several States, and it is gratifying to know that the colleges and stations recognize their duty and responsibility in this direction, for in 21 States and Territories the farmers' institutes have been committed to the management of the agricultural colleges and experiment stations, and during the past year, as has elsewhere been stated, 196 different members of these institutions have given instruction in agriculture in the farmers' institutes of this country.

THE FARMERS' INSTITUTE AND THE COMMON SCHOOL.

The institute movement was inaugurated for the improvement of the adult farmer. Its work among adults has been very valuable not only in assisting the farmer in correcting defective methods and in applying newly discovered principles in the prosecution of his art, but also in showing him how much there is of information respecting agriculture that could be imparted to the youngest child if the opportunity were given and competent teachers employed.

The adults whom the institutes have been instructing are the controlling forces in the several localities in which they live, and have power to change the methods now in use in the conduct of their public schools. The campaign of the education of these men has brought many to see the value of the scientific truths in agriculture that have been presented, and they are gradually coming to insist that this same kind of instruction shall be given to their children in the rural schools.

The enactment of laws in some of the States providing for the consolidation of schools in the rural districts is a step in this direction, and is a result due in great part to the agitation of the subject of agriculture in the public schools by the farmers' institute lecturers. State after State has come to regard with growing solicitude the situation of the youth in the country homes, and is earnestly striving to supply equal educational advantages to the rural districts that the towns and cities now enjoy. The one plan agreed upon as promising most in this direction is that of the consolidation or concentration of the ungraded crossroads schools into a well-organized, equipped, officered and central-graded school, to which scholars living beyond easy walking distance are conveyed in vans.

It is now clear that the work of instruction in agriculture, if it is to ultimately revolutionize the art, can not be confined to teaching grown-up scholars, but must be begun between the ages of 6 and 18 years, and one of our great agricultural States has come to an appreciation of this fact. In that State the superintendent of public instruction has made it obligatory upon the part of teachers in the public schools to be prepared to pass an examination upon natural science subjects which relate to agriculture, and in that same State professorships of agriculture have been introduced into the normal schools.

The future lines of development of the institute must also unquestionably be in the direction of reaching the young people who are starting out in life, and immediate steps should be taken to adapt the institute for the efficient performance of this new work. Reference has already been made in this report to one possible method that could be used by the institutes in interesting and instructing country children.

THE INSTITUTE FIELD.

The field covered by the institutes is wide and the movement is yet in its infancy. Much better methods, more comprehensive as well as more efficient, will have to be employed before the work can be perfected. The problems that are involved in meeting the requirements of agriculture in an educational sense are such as will tax the resources and thought of the best-educated leaders of our time. It is not too early for this Department to begin to plan for shaping and assisting the great work that has been developing so rapidly in recent years. This obligation has been recognized in part in providing a special officer to gather information and render assistance to the several States.

An outline of the work that can be undertaken by the Department with the means now at its command was presented by the institute specialist before the American Association of Farmers' Institute Workers, at its recent meeting in Toronto, in answer to the question

"How the National Department of Agriculture may, through its institute officer, assist the State institute meetings." That portion of the paper which gives specific answers to the question just stated is incorporated in this report, and is as follows:

There are three distinct classes of people upon whom the life and progress of the farmers' institute depends:

- (1) The State director of institutes or person in general control;
- (2) The local manager of institutes comprising the local board;
- (3) The lecturers or teachers who undertake to instruct the people in the art and science of agriculture.

The Department can assist the State director or other officers in charge of the farmers' institutes in a State—

(1) By furnishing him with data respecting the methods of conducting the institute work in other States;

(2) By keeping him informed in advance as to the places selected for institutes, the dates upon which they are to be held, and the speakers who are to be present in all of the States;

(3) By placing him in communication with the institute lecturers of the country;

(4) By aiding in securing the interest and cooperation of agricultural college and experiment station experts in his work;

(5) By sending experts either from the Department of Agriculture at Washington or from such of the corps of agricultural college and experiment station men as may be available, to assist him in his institutes;

(6) By suggesting methods for local organization;

(7) By educating lecturers for institute work by means of correspondence through the Office of Experiment Stations and by bringing them into communication with experts to give them instruction in the latest and most reliable discoveries of science along the line of their specialties;

(8) By publishing an annual report giving a synopsis of the institute work, its character and progress in all of the States.

The Department can be of assistance to the local managers, through the agency of the State directors—

(1) By sending them institute literature;

(2) By suggesting effective methods for advertising institute meetings;

(3) By furnishing model forms of programmes;

(4) By suggesting topics for discussion;

(5) By suggesting methods for creating and increasing interest in farmers' institutes;

(6) By furnishing question-box material;

(7) By calling attention to subjects that should be excluded from their institutes.

The Department can assist the institute lecturer—

(1) By placing him in communication with the director of institutes in other States;

(2) By bringing him into correspondence with scientific experts in the line of his specialty;

(3) By opening a correspondence school in the Office of Experiment Stations for institute lecturers;

(4) By using its influence in securing and providing at least some help for a course of instruction for the institute lecturer by the agricultural college of the State;

(5) By using its influence with station officers to provide for an annual visit to the State experiment station on the part of the lecturer for the study of methods of experimentation and for familiarizing him with the work of his station;

(6) By arranging for an annual meeting of lecturers at the Office of Experiment Stations in Washington for conference and for the study of the work of the Depart-

ment of Agriculture. The Department, moreover, will welcome individual lecturers at any time and for any period who come to Washington either as casual visitors or for purposes of study;

- (7) By sending him the publications of the Department of Agriculture;
- (8) By sending him lists of the experiment station bulletins of the several States;
- (9) By sending him lists of the reports of the State departments of agriculture;
- (10) By supplying him with charts relating to soils, cattle feeds, fertilizers, the composition of crops, etc., so far as the Department is able to furnish them;
- (11) By sending him lists of books which relate to his specialty;
- (12) By interesting him in and securing his attendance at the American Association of Farmers' Institute Workers.

These are some of the more obvious and direct ways by which the Department may assist the State institutes.

There are others not so direct but equally effective, such as, for instance, by endeavoring to influence the normal schools to introduce the study of agricultural science into their curricula, and the State and county teachers' institutes to devote some time to nature-study topics instead of confining their schedules, as is too often the case at present, to the presentation of worn-out and soporific discussions on abstract questions of psychology; by urging State boards of education to exert their influence in behalf of better rural schools; by urging State and county agricultural societies to make their exhibits educational and helpful instead of commonplace or a mere miniature copy of their weekly local markets; by inducing granges, alliances, and farm clubs to send representatives to the institute to take notes of the discussions and report to their societies, or better, to secure the attendance of these organizations en masse.

CONDITION OF THE INSTITUTE WORK.

In order that the condition of the institute work throughout the country might be ascertained, the following blank form, accompanied by a letter addressed to the officers having general charge of the institutes in the States and Territories, was sent out requesting them to fill in the blanks with appropriate replies to the questions asked and to return them promptly to the Office of Experiment Stations. The time covered by the report corresponds with the fiscal year of the Department, which ended June 30, 1903.

FORM OF REPORT.

Report of the director of farmers' institutes for the State of — for the year ended June 30, 1903.

1. Total number of institutes held during the year ending June 30, 1903, —.
2. Number of one-day institutes, —; two-day, —; three or more days, —.
3. Total number of sessions, —.
4. Total attendance, computed by taking the largest attendance at any one session, for each institute, —.
5. When did your institute season begin?
6. When did it end?
7. On what basis are the institutes apportioned to the several districts in your State?
8. On what basis are your funds distributed in aid of institutes?
9. What proportion of the local expenses do you, as director, pay?
10. If these expenses are provided for locally, what is the system?
11. Does the State make appropriation for institutes?

12. If so, what was the appropriation last year? —. What amount is appropriated for the coming year?
13. To whom is the appropriation made payable?
14. Have you any other funds for institute purposes outside of the State appropriation?
15. If so, give the sources and the amount? —.
16. What was the total cost of your institutes for the last institute season?
17. What was the cost per session?
18. By whom is the State director appointed?
19. For what period is he appointed?
20. What other duties does he have in addition to his work as director?
21. What office assistance does he have as director?
22. What salary does the director receive?
23. From what fund is the salary paid?
24. From what fund are the office expenses paid?
25. What provision is made for meeting the cost of postage, printing, and advertising?
26. To what extent do you, as director, attend your institutes?
27. Do you take a place regularly on the programme as a lecturer?
28. To what extent do you arrange the dates, places, and programmes for your institutes?
29. Do you publish an announcement of the dates, places, and speakers before your institute season begins? —. If so, how long in advance?
30. Do you have any special or leading topic prescribed for discussion in every institute held in your State? —. If so, what was the topic last season, and what do you propose for the coming season?
31. Do you have any definite plan for conducting the question box? —. If so, what is the plan and how do you secure its observance by the local managers?
32. Are any institutes held by localities or organizations independent of your control? —. If so, how many?
33. Under whose auspices are these independent institutes held?
34. Give an estimate of the attendance the past year at the independent institutes?
35. Do you encourage their continuance? —. If so, in what manner do you exhibit your interest?
36. Do you publish a report of the proceedings of your institutes?
37. If so, give your method for securing the reports of the proceedings, the number you publish, and the method of their distribution —.
38. Who appoints your State lecturers?
39. What compensation do they receive?
40. On what basis is the compensation rated?
41. What proportion of the time of the institute is given to the State lecturers?
42. How many state lecturers do you supply to any one institute?
43. Is the State lecture force present at your institutes selected according to any definite plan? —. If so, what is the plan?
44. Do you have rest or vacation periods for your lecturers during the institute season? —. If so, how often do they occur and for what length of time?
45. What is the method of selecting the presiding officer of the institute?
46. What is your method of advertising the institute?
47. Where are your most successful institutes held, in the town or country?
48. Do you hold sessions specially for women?
49. If so, what is your method and degree of success?
50. Do you have exhibits of agricultural implements or products at your institutes?
51. Do you have more than one set of institutes in operation at the same time?
52. If so, how many, and what plan have you adopted?

53. Do the transportation companies grant you any concessions? —. If so, to what extent?
54. What assistance does your State agricultural college furnish in institute work?
55. What assistance do you receive from the State agricultural experiment station?
56. What is your form of local organization for institutes?
57. Do you find it to be satisfactory?
58. Do your county fair and agricultural societies take any part in your institutes? —. If so, to what extent?
59. Do the county superintendents of schools, school directors, or teachers assist you in your institute work? —. If so, to what extent?
60. What are your institutes doing to improve the condition of your rural schools?
61. What are your institutes doing to improve the condition of your country roads?
62. Do you ever visit institutes in neighboring States?
63. Have you visited the homes of your lecturers to see the condition of their surroundings?
64. Do you require that your lecturers submit their addresses for criticism to make sure that they are scientifically correct?
65. Are you a member of the American Association of Farmers' Institute Workers?
66. What special new features have you introduced into your institute work during the past season, and with what results?
67. Do you hold an annual round-up institute? —. If so, do you limit the programme strictly to the discussion of institute methods, or is it general?
68. What can the Office of Experiment Stations do to assist you in making your work more effective?

(Name) ——— ———,
(Address) ——— ———.

Replies have been received from almost all of the directors—some quite complete, others but partial, and one failed to respond.

The statistical data herewith presented have been secured from the State directors of institutes, the reports of the presidents of the agricultural and mechanical colleges to the Secretary of the Interior and to the Secretary of Agriculture, from bulletins and programmes issued by the State institute directors, and from information secured by personal visits by the institute specialist.

The purpose has been to present as complete statistics as possible in order that those who are interested may have information that is full and reliable, and also that they may be informed as to the precise character and extent of the work and the methods pursued by the several States in conducting it.

Out of 44 States reporting the source of income for institute purposes, the institutes in 33 of them are supported by appropriations by the States, 10 are sustained by local subscriptions or by agricultural college or experiment station assistance, and 1 receives appropriations both from the State and the agricultural college. This shows that there is in almost all of the States a feeling of responsibility on the part of their legislatures for the support of the farmers' institute movement. The few States in which no State aid is now given will no doubt in the near future be brought to contribute from State funds.

In reply to the question as "to what extent the State director attends his institutes," 24 reply that they have attended all or nearly all, 4 do not attend, and 12 attend part of the time.

To the query as to "whether the State director takes a place upon the regular programme," 21 replied affirmatively, 13 that they do not, and 4 that they permit their names to be placed on the programmes occasionally.

Out of 39 replies to the question as to "whether the State director arranges the dates, places, and programmes for institutes," 27 state that they complete all arrangements, 5 that this work is done by local committees, and 7 that it is effected by cooperation with the county authorities.

To the question "Do you publish an announcement of the dates, places, and speakers before your institute season begins," 29 replied that they publish these facts, and 10 that they do not.

Out of 39 who responded to the inquiry as to "whether they prescribe special or leading topics for discussion in the institutes," 13 replied that they do, 25 that they do not, and 1 that he does so occasionally.

To the question "Do you have any definite plan for conducting the question box," 9 replied that they had, and 31 that they had not.

Out of 40 States, 21 publish the proceedings of their institutes either in whole or in part, and 19 make no provision for publication.

Thirty-one reports show that in 20 States the lecturers are appointed directly by the superintendents of institutes, and in 11 of the States they are appointed by boards of agriculture, regents of the university, or by institute committees.

The compensation allowed to institute lecturers is reported by 32 directors. In 10 of the States their expenses only are paid. In 7 they receive from \$15 to \$50 per week and expenses. In 15 they receive from \$2 to \$10 per day and expenses.

In answer to the question "Where are your most successful institutes held, in the town or country," 24 reported in the "small towns," and 15 stated "in the country."

Institutes "specially for women" are held in 15 of the States reporting, none being held in the other 25.

In all of the States reporting, 43 in number, the agricultural colleges furnish lecturers for the institute work, and out of 44 States reporting, 43 experiment stations participate in lecturing before farmers' institutes.

Thirty-eight replies were received to the question, "Do your county fair associations and agricultural societies take part in your institutes." Twelve reported that their agricultural societies assist them, and 26 that they do not. Fourteen out of 39 report that they hold annual round-up institutes; the other 25 do not.

Various replies were received to the inquiry as to what the Office of Experiment Stations can do to assist in making the State institute work more effective. Twenty-three directors made definite requests. Sixteen of them asked for competent speakers, and 7 for suitable literature. Two asked for assistance in securing State organization. Two requested aid in educating their lecturers through the establishment of State normal schools, to be in session for two or three weeks each year. One asked for financial assistance, and 1 requested some suggestion as to how attendance upon their institutes can be increased.

An examination of the reports from all of the States and Territories shows that 3,106 institutes cost \$60.22 per institute; that 9,426 sessions cost an average of \$16.85 per session. There were 4,864 days of institutes in all. A summary of the reports which are comparable shows that 4,792 days of institutes cost at the rate of \$39 per day, and that the average cost for institutes to 886,654 persons was 0.022 cent per person for the year.

Twenty States reported copies of their proceedings published and issued amounting to 253,700.

Statistics giving the details of the work in each State are appended in the tabulated statement accompanying this report.

The replies received indicate what is being done in the institute work throughout the country, and show to some extent the interest that this work has excited both upon the part of the farming people who are directly benefited and also of those who have in charge the general system of public education. The colleges and stations have with one exception been active in their support of this movement. There has been lack of organized cooperation on the part of the local agricultural societies in many of the States. This is a source of influence that ought to be enlisted in support of the institute movement.

It is unfortunate that full statistics could not be secured from all of the States so as to be able to show the condition of the work in all of the respects indicated in the blank form submitted. It is hoped that the directors will arrange to secure data so that it will be possible to present a complete report next year.

Some statistics taken from the Census Report for the year 1900 are also given, showing the population of the several States, the number of homes in each State, and the percentage of the whole number of homes that are distinctly farm homes. From these data an approximation of the number of people who live in farm homes is given.

This approximation is arrived at by estimating that the number of persons in a farm home is equal to that in other homes, and that the per cent of farm homes is, therefore, also the per cent of rural population.

This estimate is not strictly accurate, for the Census enumerators in

taking account of farm homes did not include a home, although situated in the country, which "consists of only a dwelling and ground upon which it stands, with appurtenances thereto, but is not occupied by what may be termed a farm family." (Census Report of 1900, pt. 2, Population, p. CLXXXVII.) Neither are there included farm laborers who reside in towns and cities, but who work out on farms. The figures, therefore, given for farm population are below rather than above the actual number engaged in agriculture.

FARMERS' INSTITUTES IN THE SEVERAL STATES AND TERRITORIES.

ALABAMA.

Population 1,828,697. Total number of homes 374,765. Number of farm homes 217,461. Per cent of farm homes 58. Approximate population in farm homes 1,060,644.

Director of institutes.—C. A. Cary, Veterinarian, Alabama Polytechnic Institute and Agricultural Experiment Station, Auburn.

The farmers' institute work in Alabama is under the direction of the board of trustees of the Alabama Polytechnic Institute and of the agricultural experiment station. There is no State law regulating or directing the work. Last year there was appropriated by the college \$600 for institute expenses, and eleven lecturers were employed for institute services. Twenty-two institutes were held, consisting of 50 sessions, with a total attendance of 2,618.

No report of institute proceedings is printed. The director is appointed for the period of one year by the board of trustees of the college and station. Eight members of the college and station staffs participated in the institute work, aggregating 52 days of service. There are no permanent local institute organizations, the director arranging for the dates, places, and programmes, as well as advertising the institutes. A ten-day round-up institute, or convention of institute workers, was held last year at the college. The sum of \$800 has been appropriated for the institute season ending June 30, 1904.

ALABAMA INSTITUTES FOR COLORED PEOPLE.

G. W. Carver, Director, Department of Agriculture and Experiment Station, Tuskegee Normal and Industrial Institute, Tuskegee.

Farmers' institutes for colored people have been organized under the direction of the Tuskegee Normal and Industrial Institute. About 10,000 colored people are reported to have been in attendance during the past year at the institute meetings. The expenses of the institutes are met by the localities in which they are held. The meetings are advertised by circulars, personal letters, and through the various pulpits of the surrounding country. The formation of local organiza-

tions to meet once each month is encouraged. A general conference, known as the Tuskegee Normal Conference, took place at the industrial institute last February, largely attended by farmers from all over the State. The lecture service is performed chiefly by the members of the Tuskegee Institute.

ALASKA.

Population 63,592. Total number of homes 13,459. Number of farm homes 27. Per cent of farm homes 0.2. Approximate population in farm homes 127.

Director of institutes.—C. C. Georgeson, Special Agent in Charge of Experiment Station, Sitka.

Farmers' institutes have not yet been organized in Alaska, but the special agent in charge of the experiment station, as he visits the various districts, takes advantage of the opportunity to give advice as to the methods that might be used in improving the agriculture of the several localities.

ARIZONA.

Population 122,931. Total number of homes 29,875. Number of farm homes 7,391. Per cent of farm homes 24.7. Approximate population in farm homes 30,362.

Director of institutes.—R. H. Forbes, Director Agricultural Experiment Station, Tucson.

Farmers' institutes in Arizona have been held under the direction of the State University, and until this year no specific appropriation had been made by the legislature for meeting the expenses of institute work. Two institutes consisting of 20 sessions were held by four members of the college and experiment station staffs. The director reports an attendance of 1,000.

The legislative assembly this year passed an act providing for the establishment of farmers' institutes throughout the Territory, and appropriated \$2,700 for the purpose of meeting the expenses. This sum is to be available for the season of 1903-4. The new law places the control of the institutes in the hands of the board of regents of the university.

CALIFORNIA.

Population 1,485,953. Total number of homes 341,781. Number of farm homes 74,119. Per cent of farm homes 20.8. Approximate population in farm homes 308,891.

Superintendent of institutes.—E. J. Wickson, University of California, Berkeley.

The institute work in California is under the general direction of the superintendent of farmers' institutes, assisted by two conductors, one having the central and northern portions of the State, and the other having charge of the institute work in the southern section.

The last legislature by act approved March 18, 1903, authorized the board of regents of the University of California to hold farmers' insti-

tutes under such rules and regulations as they may deem proper and at such times and places as they may direct. The sum of \$12,000 was appropriated for institute work for the next two fiscal years. During the past year \$4,000 was spent by the university in paying the salaries of the conductors of institutes, the expenses of lecturers, hall rent, advertising, etc.

Sixty institutes were held during the year made up of 254 sessions. The total attendance is given at 20,000. Ten thousand copies of the proceedings are prepared and printed in the agricultural report, and abstracts published by the agricultural journals. Thirteen members of the college and station staffs participated in the work, attending all of the institutes and aggregating 131 days of service. The arranging of dates, places, and programmes for institutes is in the hands of the superintendent. A number of independent agricultural institutes were held at which the estimated attendance was about 5,000. The superintendent reports that the most successful meetings are held in country districts. No general round-up institute was held for the State, but a very successful meeting of farmers' clubs was held in southern California made up of delegates from 35 societies, and continuing for four days. Another six-day meeting was held at a sea-side camping place in southern California with good results.

The superintendent provides two lecturers for each one-day institute, and three lecturers for each institute continuing two days or more. There are no special or permanent local organizations in the several counties, but a local committee appointed by the last institute takes charge, under the general direction of the State superintendent, of the work of preparation for future meetings.

COLORADO.

Population 539,700. Total number of homes 127,459. Number of farm homes 24,745. Per cent of farm homes 19.4. Approximate population in farm homes 104,701.

Director of institutes.—B. O. Aylesworth, President State Agricultural College, Fort Collins.

There are no specific laws in this State in regard to farmers' institutes. The work has been conducted by the State Agricultural College and the funds with which to carry it on have been contributed by this institution. Ten institutes were held last year, made up of 20 sessions, and an attendance of about 1,300 persons. The total expense was \$385. The lecture force was provided from the staffs of the agricultural college and experiment station. Nine persons were sent out on this service, contributing in the aggregate sixty-five days of time. There has been no arrangement made for the publication of the proceedings.

CONNECTICUT.

Population 908,420. Total number of homes 203,424. Number of farm homes 26,609. Per cent of farm homes 13.1. Approximate population in farm homes 119,003.

Superintendents of institutes.—James F. Brown, Secretary State Board of Agriculture, North Stonington; J. B. Noble, Secretary Connecticut Dairymen's Association, Hartford; H. C. C. Miles, secretary Connecticut Pomological Society, Milford.

Connecticut has no special law regulating the holding of farmers' institutes. The State board of agriculture, the Connecticut Dairymen's Association, and the Pomological Society are each carrying on institute work in the State. The methods used by these different organizations in carrying out their work and disseminating information are entirely in their own discretion. Each, however, has a committee appointed to have charge of the institute work. The board of agriculture requires that localities applying for institutes shall "furnish a suitable hall, provide local transportation for speakers and visitors, music, if desired, and entertain by collation, or otherwise, unless there are convenient hotel accommodations." The board pays for printing, traveling expenses, and services of speakers.

Nine institutes were held during the past year, made up of 25 sessions and attended by 4,000 persons. Twenty-one different speakers were on the institute force of the State. The total expense amounted to \$700. Five thousand copies of reports of the proceedings were printed and distributed. The appropriation for institutes is by the board of agriculture which receives \$3,500 annually for all purposes. Six other institutes were held by the State Pomological Society, the State Dairymen's Association, and the Tobacco Growers' Association. There are no specific local organizations for conducting institutes, but the superintendents depend upon the local granges and farm clubs for cooperation.

DELAWARE.

Population 184,735. Total number of homes 39,446. Number of farm homes 9,677. Per cent of farm homes 24.5. Approximate population in farm homes 45,260. Director of institutes.—Wesley Webb, Dover.

Until this year the farmers' institute work in Delaware was organized by counties, each of the three counties having a separate institute director. The legislature of 1903 amended the law by providing "that the State board of agriculture may appoint a director of farmers' institutes for the State to cooperate with the farmers' institutes of the several counties." The sum of \$600 annually is appropriated, being \$200 to the institutes in each county. The salary of the superintendent is provided for outside of this amount. The law provides that the failure of any county to hold an institute in any year shall forfeit its appropriation for that year.

Twenty-eight institutes were held during the past season made up of 67 sessions, and attended by 4,800 persons. Nineteen lecturers were on the State force. The total expense amounted to \$800. Four members of the agricultural college and experiment station staffs were in attendance as lecturers and contributed fifteen days of time. The director of institutes is also secretary of the State board of agriculture. The local organizations are provided for under an act of the legislature of May, 1889, which requires that there shall be a president, vice-president, secretary, treasurer, and an executive committee for each county organization, and that these officers shall receive no compensation and are to hold their office for one year. No report of the proceedings has heretofore been published, but the superintendent states that they expect to issue a report in the future.

FLORIDA.

Population 528,542. Total number of homes 117,001. Number of farm homes 40,965. Per cent of farm homes 35. Approximate population in farm homes 184,989.

Director of institutes.—C. M. Conner, Florida Agricultural College, Lake City.

Authority to hold farmers' institutes is committed by the State to the board of trustees of the Florida Agricultural College and the Experiment Station. The appropriation to these institutions contains the following clause: "For holding farmers' institutes, \$2,500." The superintendent is appointed by the board of trustees, and last year under his direction 21 institutes were held, consisting of 42 sessions. Two thousand nine hundred persons were in attendance, and 22 State speakers gave instruction. The total cost of the institutes was \$2,500. The agricultural college and experiment station staffs were represented by 2 lecturers from their force, who contributed 30 days of time. The local organization consists of a chairman in each county appointed by the superintendent of institutes, with authority to make all necessary local arrangements for institute meetings. Five thousand copies of reports of the proceedings were distributed last year. The superintendent, in addition to his duties as director of farmers' institutes, is also professor of agriculture in the agricultural college of Florida. The dates and places for all institutes are arranged by the superintendent, and notices of meetings are published from 3 to 4 weeks in advance.

GEORGIA.

Population 2,216,331. Total number of homes 455,557. Number of farm homes 221,395. Per cent of farm homes 48.6. Approximate population in farm homes 1,077,136.

Director of institutes.—H. C. White, President of the State College of Agriculture and Mechanic Arts, Athens; Harvie Jordan, Assistant Director of Institutes, Monticello.

There is no law in this State providing for the holding of farmers' institutes. The work has been conducted by the college of agriculture of the State University, and the money needed for carrying on the work has been appropriated by the trustees of that university. The general direction of the work is in the hands of the president of the agricultural college, aided by a field assistant, Mr. Harvie Jordan, of Monticello. One thousand dollars was set aside by the trustees of the university for bearing the expenses of institutes for the past year. Fifteen institutes were held, consisting of 32 sessions, attended by about 3,500 persons. Eight lecturers were upon the State force, 6 of whom were representatives of the faculty of the college or the station staff, who contributed 13 days of their time to institute lecture service.

No institutes had been held in Georgia for several years until the past season. The purpose of the director is to organize a farmers' institute in every senatorial district in the State. Each locality is expected to secure a suitable hall for meeting, without charge to the State superintendent, and to provide all of the local accommodations needed for successfully conducting the meeting. The State supplies 2 lecturers to each institute, whose expenses are paid out of the agricultural college funds. The dates, places, and programmes for the institutes have thus far been arranged by the director, and the meetings are advertised at least 2 weeks in advance by means of the county press. No report of the proceedings is published. In addition to the institutes held by the college of agriculture of the State University, one meeting was held by the Georgia State Industrial College, at which there were present about 1,000 farmers. The meeting was conducted by 3 members of the college staff.

HAWAII.

Population 154,001. Total number of homes 36,922. Number of farm homes 1,409. Per cent of farm homes 3.8. Approximate population in farm homes 5,852.

President of institutes.—Jared G. Smith, Special Agent in Charge of the Agricultural Experiment Station, Honolulu.

There are no laws in force in this Territory relating to farmers' institutes. A farmers' institute society was organized January 25, 1902, and quarterly meetings have been held regularly since. Seventy-five persons have enrolled themselves as active members. No funds have as yet been appropriated by the local legislature for assisting in the institute work. Four institutes were held during the past season, consisting of four sessions, with an attendance of 160. The cost of these meetings was \$35. All of these meetings were conducted by the experiment station staff. A report of the proceedings has been made, but owing to lack of funds has not been printed. One hundred and fifty dollars has been appropriated for institutes for the coming year.

The arranging of dates, places, and programmes is left entirely to the president of the institute society. Two independent institutes were held during the year, with an estimated attendance of about 100.

IDAHO.

Population 161,772. Total number of homes 37,491. Number of farm homes 17,153. Per cent of farm homes 45.8. Approximate population in farm homes 74,091.

Superintendent of institutes.—H. T. French, Director Agricultural Experiment Station, Moscow.

The last legislature appropriated \$2,000 for institute work for two years. The control of the institutes and the expenditure of the money are intrusted to the board of regents of the college of agriculture of the University of Idaho. Seventeen institutes were held during the year, made up of 75 sessions. Two thousand five hundred and fifty persons were in attendance. There were 9 lecturers on the State force, of whom 6 were furnished from the agricultural college and station staffs, who attended all of the institutes, contributing 60 days of their time. The dates, places, and programmes are all arranged by the superintendent of institutes. The principal topics discussed last year were sugar-beet culture, dairying, horticulture, stock breeding, and feeding. Announcements of the dates, places, and speakers are made from four to eight weeks in advance of the meetings. Brief reports of the discussions are prepared by the secretary and published and distributed. The form of local organization consists of a chairman elected at the institute meeting and a secretary appointed, together with such special committees as are needed.

ILLINOIS.

Population 4,821,550. Total number of homes 1,036,158. Number of farm homes 262,388. Per cent of farm homes 25.3. Approximate population in farm homes 1,219,852.

Superintendent of institutes.—A. B. Hostetter, Secretary Illinois Farmers' Institutes, Springfield.

The Illinois Farmers' Institute is organized under special act of the legislature and is a public corporation of the State. "It consists of three delegates from each county of the State, elected annually at the farmers' institutes of the county," and is managed by a board of trustees "consisting of the State superintendent of public instruction, the professor of agriculture of the University of Illinois, the president of the State board of agriculture, the president of the State Horticultural Society, the president of the State Dairymen's Association, and one member from each Congressional district of the State, to be selected by the delegates from the district present at the annual meeting." The officers of this board of directors are a "president,

vice-president, secretary, treasurer, a State superintendent of farmers' institutes, and such other officers or agents as may be deemed proper for organizing and conducting the work of the organization, all of whom shall hold their office for one year, unless removed sooner by the board, and shall perform such duties as may be required of them by the rules of the board."

Article 5 of the act prescribes the duties of the State superintendent of institutes:

SECTION 1. The State superintendent of institutes shall have general supervision of institute work in the State under the direction of the board of directors and of the executive committee.

SEC. 2. He shall make recommendations as to lines of work which he believes will prove profitable for the ensuing year, together with general plans for their execution and estimates of expenses. He shall make such other recommendations to the board of directors as he may deem for the best interest of the institute work.

SEC. 3. He shall visit the county institute and district conferences when invited to do so by the county institute officers or directors, or when in his judgment the institute work demands such visit.

SEC. 4. He shall have charge of the publication of the annual report, and shall insert therein such matters as will advance the agricultural interests of the State, under the direction of the executive committee.

SEC. 5. He shall be librarian of the farmers' institute free libraries, and shall submit to the board of directors or to the executive committee, for approval, lists of books which he deems ought to be purchased for the use of the libraries when such are needed.

SEC. 6. He shall make a detailed annual report in writing to the board of directors at the last meeting of the old board, of his acts and doings during the year, together with a general summary of the institute work of the State for the year; he shall also make such other reports during the year as the board of directors or executive committee may require.

One hundred and eight institute meetings were held last year, 68 being two days and 40 being three or more days. Eighty-four speakers are on the lecture force and 42,876 persons were in attendance. The appropriation amounted to \$18,150. An annual report is made and distributed. Seven members of the agricultural college and experiment station staffs were reported on the institute lecture corps, who devoted 23 days to this service. The local organizations in the several counties elect their own officers and formulate their own rules. They are permitted to select their own speakers and to choose such topics for consideration as they consider will be of interest to their respective localities. Each county farmers' institute is entitled to the sum of \$75 per annum on condition "that such institute shall file with the secretary of the Illinois Farmers' Institute a sworn statement which shall show that said county farmers' institute has held one or more duly advertised public sessions annually, of not less than two days each, at some easily accessible location." This statement shall also

include "an itemized exhibit of the expenses of the meeting with receipted vouchers therefor, a copy of its printed programme and the printed proceedings showing the title and author of the papers read and by whom discussed, place or places of meeting, with average daily attendance, and such other information as may be called for by the Illinois Farmers' Institute and necessary to successfully assist this work." The Illinois Farmers' Institute is authorized to award one free scholarship in the college of agriculture, good for two years, for each county in the State, and one for each Congressional district of Chicago. The awards are made on the recommendation of the farmers' institute director for each Congressional district. Free circulating libraries are distributed among the several county institutes. Fifty-one of these libraries have been equipped and sent out, containing about 50 volumes.

The Illinois Farmers' Institute is required to make an annual report to the governor of its transactions, which report shall include papers pertaining to its work and addresses made at the annual meeting of the organization. Twenty thousand copies of this report are required to be printed each year, one-half for the use of the Illinois Farmers' Institute and the remainder to the secretary of the State for distribution.

INDIANA.

Population 2,516,462. Total number of homes 571,513. Number of farm homes 221,451. Per cent of farm homes 38.7. Approximate population in farm homes 973,870.

Superintendent of institutes.—W. C. Latta, Professor of Agriculture in the School of Agriculture, Horticulture, and Veterinary Science of Purdue University, Lafayette.

The laws of the State of Indiana require the committee of experimental agriculture and horticulture of the board of trustees, together with the faculty of the school of agriculture of Purdue University, to appoint persons to hold county institutes in the several counties of the State. Ten thousand dollars per annum has been appropriated for bearing the expenses of the lecturers and such other items as may be necessary for the proper conduct of the work. The director of institutes is appointed by the trustees of Purdue University, the present officer being the professor of agriculture in the university, and advisory agriculturist of the experiment station.

During the year 181 institutes were held, comprising 858 sessions, and attended by 73,653 persons. The number of lecturers upon the State force was 39. The schedule, including dates, places, and programmes, is arranged by the superintendent, and the places are decided by conference with the local officers. The local committees usually arrange the programmes. Two State lecturers are provided for each institute, with an occasional extra speaker to discuss some special topic. Members of the college and station staffs attend institutes without

charge except for their expenses and at times when other duties do not seriously interfere. The local organizations are effected by having a chairman, secretary, and a vice-president for each township, chosen at the county meeting for the ensuing year. The advertising of the institute is left entirely to the local organization, which for this purpose uses postals, postal-card programmes, personal letters, and the local press. Six hundred copies of abstracts of the proceedings are printed and distributed each year. In addition to the number of meetings above given, there were held two district institutes and an annual conference, the purpose of the conference being to prepare local managers and speakers for the coming season's campaign.

INDIAN TERRITORY.

Population 302,060. Total number of homes 76,701. Number of farm homes 47,594. Per cent of farm homes 62.1. Approximate population in farm homes 187,579.

Farmers' institutes have not been organized in the Territory.

IOWA.

Population 2,231,853. Total number of homes 480,878. Number of farm homes 223,525. Per cent of farm homes, 46.5. Approximate population in farm homes 1,037,811.

Director of institutes.—J. C. Simpson, Secretary of the State Board of Agriculture, Des Moines.

There is no central organization or State superintendent of farmers' institutes in Iowa, but each county is entitled to organize an institute when forty or more farmers meet and elect a president, secretary, treasurer, and an executive committee of not less than three outside of such officers, and hold an institute remaining in session not less than two days in each year. Upon presenting proof to the county auditor of such organization and such institute having been held, and an itemized statement showing the manner in which the money used has been expended, it is the duty of the county auditor to certify the statement to the auditor of the State, who upon receipt of such certification is required to remit to the treasurer of the county his warrant not to exceed \$75 in any one year.

The absence of any State organization, or central office, or board of control has made it difficult to secure data respecting the work. The secretary of the State department of agriculture has made an estimate of the attendance. There are 99 counties in the State, each of which is entitled to \$75 for institute purposes, making the appropriation available \$7,425. Sixty-four counties held institutes this year—50 two days, and 14 three or more days. The total number of sessions was 348. The attendance is given at 17,750. No report is published of the institute proceedings.

KANSAS.

Population 1,470,495. Total number of homes 321,947. Number of farm homes 167,006. Per cent of farm homes 51.9. Approximate population in farm homes 763,186.

Director of institutes.—J. T. Willard, Director Agricultural Experiment Station, Manhattan.

The legislature of 1903 passed an act providing for the formation of county farmers' institute associations. Such association under this act shall consist of a president, vice-president, secretary and treasurer, and it must adopt a constitution and by-laws for its government. The county institute association is entitled to the sum of \$50 from the county to defray the legitimate expenses of a two days' institute, and the legislature has provided in addition an appropriation of \$2,000 per year to the State agricultural college, to be used in paying the expenses of the members of the college faculty and experiment station who attend institutes. The duties of State directors are performed by the chairman of a committee appointed by the president of the college on institute work. Ninety-two institutes were held during the year, composed of 204 sessions. Eighty-two of the institutes were one-day and 10 were two-day. The total attendance was 38,085. The number of speakers upon the State corps was 16. The college and station staffs attended 90 institutes, giving 200 days of their time. The chairman of the State institute committee arranges the dates, places, and programmes for institute meetings. The said corps of lecturers is composed of members of the college faculty and station force. The proceedings are not published except brief abstracts by the farm papers.

KENTUCKY.

Population 2,147,174. Total number of homes 437,054. Number of farm homes 234,821. Per cent of farm homes 53.7. Approximate population in farm homes 1,153,032.

Director of institutes.—I. B. Nall, Commissioner of Agriculture, Frankfort.

Kentucky has no specific farmers' institute law. The work is conducted under authority given in the general law prescribing the duties of the State bureau of agriculture in which the commissioner is directed to "promote and encourage, as far as practicable, societies and other associations in the several counties." Eight institutes were held during the year, attended by 2,000 persons. Eleven lecturers are upon the State institute force. Three of these are from the agricultural college and experiment station staffs, who attended five institutes, giving in the aggregate fifteen days of their time to institute work. The sum of \$13,000 is annually appropriated to meet the expenses of the bureau of agriculture. Of this sum \$1,200 was appropriated by the bureau for institute purposes. The proceedings are edited by the State director and printed in supplement form, and circulated by the

leading agricultural papers in the State. The county papers also inclose these supplements, distributing them among their subscribers. About 8,000 copies of the proceedings of each institute were printed and circulated in this manner during the past year.

The work of arranging for institutes in the several counties is in the hands of the superintendent, who cooperates with local farm clubs in arranging the dates, places, and programmes, the State furnishing such additional lecturers as may be necessary. The dates, places, and speakers are announced as soon as the programme has been prepared through the State agricultural papers as well as by means of local publications.

LOUISIANA.

Population 1,381,625. Total number of homes 284,875. Number of farm homes 114,214. Per cent 40.1. Approximate population in farm homes 554,031.

Director of institutes.—J. G. Lee, Commissioner of Agriculture, Baton Rouge.

Under the constitution of 1898 the Louisiana State board of agriculture and immigration were given control and direction of all State agricultural organizations and State farmers' institutes. The board organized a farmers' institute committee, composed of the president of the Louisiana State University, the director of the State experiment station, and the commissioner of agriculture and immigration. Two thousand dollars is annually appropriated for institute work. The commissioner of agriculture and immigration is the executive officer of the State committee on farmers' institutes, and has direct control of the work of organizing and conducting institutes in the several districts. The commissioner reports 13 persons on the State institute lecture force. Fifty institutes were held last year. Forty-eight were one-day and two were three-day, aggregating 134 sessions. The total attendance was 13,245. The amount appropriated for institute purposes was \$2,000. Three thousand five hundred copies of reports of institute proceedings were printed and distributed. Permanent institute clubs with a president and secretary, with one vice-president from each ward of the parish, constitute the local organization. The institute director cooperates with the local authorities in arranging dates, places, and programmes for institute meetings. The State director of institutes is appointed by the governor for a period of four years, and is also commissioner of agriculture and immigration.

MAINE.

Population 694,466. Total number of homes 163,344. Number of farm homes 57,153. Per cent of farm homes 35. Approximate population in farm homes 243,063.

Director of institutes.—A. W. Gilman, Commissioner of Agriculture, Augusta.

In Maine under the act creating the State department of agriculture, and providing for the appointment of a commissioner of agriculture, the commissioner is required to "hold or cause to be held two farm-

ers' institutes in each county annually, and as many more as the appropriation therefor will allow." Three thousand dollars is annually appropriated for the institute work. During the year 40 institutes were held, composed of 83 sessions; 5,846 persons were in attendance. Nine lecturers are upon the State force. Abstracts of the proceedings are prepared by the commissioner and are included in his annual report, of which 6,000 copies are printed. The commissioner is appointed by the legislature and holds office for two years. The location of the county meetings is made by the county agents, and the dates and programmes are planned by the State director of institutes. The agricultural college and experiment station officers participated in the lecture work whenever desired and at times that did not conflict with their other duties.

MARYLAND.

Population 1,188,044. Total number of homes 242,331. Number of farm homes 47,089. Per cent of farm homes 19.4. Approximate population in farm homes 230,480.

Director of institutes.—W. L. Amoss, College Park.

Under the State law the farmers' institute director of Maryland is appointed by the trustees of the Maryland Agricultural College, and at least "one institute is required to be held in each year in each county of the State, and an additional one in each county if deemed necessary and desirable." The institute under this act was made a department of the Maryland Agricultural College. Forty institutes were held last year, consisting of 116 sessions; 11,222 persons were in attendance. There were 7 lecturers upon the State force. The members of the agricultural college faculty and of the experiment station devoted 56 days of their time to assisting in the institute work. The work in the several counties is conducted by a local committee, or county organization wherever they exist, or through a local correspondent appointed by the director of institutes. Reports of the institutes are furnished to the county papers, and enough of these are secured by the director to supply his mailing list. The advertising of the meetings is effected through the newspapers of the State by sending to each a programme about four weeks before the institute in the county in which the newspaper is published is held. Four thousand dollars was appropriated last year for institute expenses. The director each year plans a visit of representatives of the institutes in the several counties to some place of special interest outside of the State, as a farm, canning factory, city market, or educational institution, each delegate being expected to write a report of what he has observed during his visit, and present this before the next institute meeting. The results from this method of verifying information have been very satisfactory.

MASSACHUSETTS.

Population 2,805,346. Total number of homes 613,659. Number of farm homes 36,510. Per cent of farm homes 5.9. Approximate population in farm homes 165,515.

Director of institutes.—J. L. Ellsworth, Secretary State Board of Agriculture, Boston.

The farmers' institutes of Massachusetts are held under a general law establishing the board of agriculture, which authorizes it to "disseminate useful information in agriculture by lectures or otherwise." By a rule of the State board the secretary of the board is required to provide lecturers for farmers' institutes so far as the appropriation for the object will allow. The board recommends "that whenever any farmers' organization in the State shall desire to have a course of not more than three lectures on any farm subject they may apply to the secretary of the board of agriculture for a lecturer, and the secretary, if he thinks the subject a proper one, shall furnish a lecturer, providing he can secure a competent person to attend on the dates named, and also providing that he has not already been called on during the year to provide lecturers for more than thirteen courses."

One hundred and twenty institutes, composed of 154 sessions, were held this year. Twelve thousand four hundred and eighty-seven persons were in attendance, and there were 68 lecturers upon the State force engaged in giving instruction at these meetings. Two thousand dollars was appropriated for meeting the necessary expenses of the State lecturers. The local expenses are met by the societies holding the meetings. Eight members of the agricultural college and station force delivered lectures at 14 institutes, contributing in the aggregate 28 days of time. The dates, places, and programmes for the meetings are arranged by the State director in cooperation with the local officials. The agricultural societies represented on the State board of agriculture are the local organizations under whose auspices the institutes are held.

MICHIGAN.

Population 2,420,982. Total number of homes 548,094. Number of farm homes 202,457. Per cent of farm homes 36.9. Approximate population in farm homes 893,342.

Superintendent of institutes.—L. R. Taft, Horticulturist of the Experiment Station of the Michigan Agricultural College, Agricultural College.

The State board of agriculture is authorized by act of the legislature of 1901 to "hold institutes and to establish and maintain courses of reading and lectures for instruction in the various branches of agriculture, mechanic arts, domestic economy, and the related sciences." The board is authorized to "formulate such rules and regulations as it shall deem proper to carry on the work contemplated in the act, and

may employ such agent or agents to perform such duties in connection therewith as it shall deem best."

Local county farmers' institute societies are provided for in the act, and such societies are required to hold annually at least one institute of at least two days in length. To organize a local county institute society the rule of the board requires that at least "twenty residents of the county, without regard to sex, but of legal age, shall meet and adopt a brief constitution in harmony with the State law, elect a president and vice-president from each township in the county, and a secretary, who shall also be treasurer. Such society shall furnish to the secretary of the board of agriculture a copy of its constitution and by-laws, and shall transmit with the same a written agreement, signed by the president and secretary of the society, stating that the society will, for purposes of farmers' institutes, conform to the rules of the board of agriculture governing such institute. Within ten days after the close of each institute the secretary shall make a report to the superintendent on blanks to be furnished by the superintendent." The immediate management of the farmers' institutes is placed in charge of a superintendent elected by the board of agriculture. The superintendent arranges for locating and holding institutes, is authorized to approve all institute societies when properly organized, and, after consultation with members of local institute societies, determine the time and place for holding the institutes and the subjects to be discussed. He also designates the persons who are to attend as lecturers, and has authority to reject from the programme local speakers or topics that are objectionable. He has authority to call upon the faculty and instructors of the agricultural college and the members of the experiment station force for such institute work as may be assigned them by the board with the consent of the president.

During the past year 284 institutes were held, consisting of 885 sessions. Two hundred and thirteen of these institutes were one-day, 70 were two-day, and one three-day. The total attendance was 53,037. There were 97 speakers upon the State lecture force. Sixteen members of the college faculty and of the experiment station staff assisted in this work. The appropriation for the expenses of the lecture force was \$7,500. Reports containing statistics of attendance, list of officers, etc., and a report of the annual round-up institute, together with such papers as are of special excellence read at the county institutes, are edited by the State superintendent, and 8,000 copies were published for distribution by the institute societies. A round-up of institute workers is held each year.

MINNESOTA.

Population 1,751,394. Total number of homes 342,658. Number of farm homes 152,393. Per cent of farm homes 44.5. Approximate population in farm homes 779,470.

Superintendent of institutes.—O. C. Gregg, Lynd.

The legislature of Minnesota, by act approved April 14, 1903, repealed all former legislation with regard to farmers' institutes in that State, and provided for their future constitution, government, and support in an entirely new act composed of fifteen sections. A board of administration is created by the act consisting of three members of the board of regents of the University of Minnesota, the president of the State Agricultural Society, the president of the State Dairy Association, and the president of the State Horticultural Society, to have charge of the execution of the act regulating the farmers' institute work throughout the State. This board of administration is authorized to appoint a State superintendent of farmers' institutes whose term of office continues for two years. The board of administration, in conjunction with the superintendent, arranges the institute circuits and determines the times and places where institutes are to be held. The duties of the superintendent are defined as follows: "To superintend the several institutes when located as herein provided; to engage competent instructors therefor; to receive, examine, and report upon all bills for expenses and services payable from established appropriation; and at the end of each fiscal year to make a detailed report of all farmers' institutes held under his direction, with an itemized account of all expenditures under this act during the year last past, to said board of administration." The board of administration is directed to prepare and publish each year a Farmers' Institute Annual. Thirty thousand copies of this publication were sent out last year. One hundred institutes were held during the season, consisting of 238 sessions. Eighty-five institutes were one-day and 15 were two-day. The total attendance was 35,171. Thirteen lecturers were upon the State institute corps. The appropriation for institute expenses was \$16,500. The college and experiment station were represented by one member, who attended nineteen meetings, amounting to nineteen days of service. There are no local county organizations of institutes in the State, the superintendent selecting persons in each locality from year to year to assist him in organizing and conducting the local work.

MISSISSIPPI.

Population 1,551,270. Total number of homes 318,948. Number of farm homes 221,110. Per cent of farm homes 69.3. Approximate population in farm homes 1,075,030.

Director of institutes.—J. C. Hardy, President Mississippi Agricultural and Mechanical College, Agricultural College.

Farmers' institute work in Mississippi is under the direction of the president of the agricultural and mechanical college. There are no laws organizing institutes in the State excepting that which makes an appropriation to the agricultural and mechanical college for institute work. Last year 58 institutes were held, composed of 122 sessions. Fifty-six were one-day meetings and two were two-day meetings. The total attendance was 10,000. There were 15 lecturers upon the State lecture corps, 9 of whom were members of the college and experiment station staffs. The college and experiment station lecturers participated in all the meetings that were held. One thousand five hundred dollars was appropriated for institute work, and 18,000 copies of institute reports were published and distributed among the farmers of the State.

The State director organizes the farmers in the several localities into clubs, and the clubs of each county into a single county club, the county club having charge of the local institute work. He also fixes the dates and places for institutes, committing the preparation of the programmes and the arrangement of speakers to the county institute club. Announcement of dates, places, and speakers is made about one month before an institute meeting is held, by publishing the programme in the county papers. The State director is appointed by the board of trustees of the agricultural and mechanical college, and the appropriation made by the State is payable to this board of trustees.

A round-up meeting of institute workers was held this year at which about 400 farmers from the various districts of the State were present. An effort is to be made the coming year to organize a permanent farmers' club in each county, to have charge of the local work connected with the farmers' institute meetings.

MISSOURI.

Population 3,106,665. Total number of homes 654,333. Number of farm homes 282,840. Per cent of farm homes 43.2. Approximate population in farm homes 1,340,079.

Director of institutes.—George B. Ellis, Secretary State Board of Agriculture, Columbia.

The control of farmers' institutes in Missouri is by law placed in the hands of the State board of agriculture, which is required to "hold farmers' institutes in different parts of the State for the purpose of giving instruction in agriculture." The execution of this work is placed in the hands of the secretary of the board. One hundred and twenty-seven institutes were held during the year, attended by 25,400 persons. Thirty-one lecturers were upon the State institute staff, ten of whom were members of the agricultural college faculty

and experiment station force. These college and station men gave 120 days of time, and were present at all of the institutes that were held. Four thousand dollars was appropriated by the State for institute work, made payable to the board of agriculture. There are no permanent local organizations for institute purposes in the several counties, the director arranging each year for the institutes by correspondence from the office with a local committee, which he appoints. The director fixes the dates and places and consults with the local committee respecting the programmes. Meetings are advertised by publishing from two to four weeks in advance the dates, places, and names of the speakers in the local press. A traveling institute was organized two years ago and was in successful operation during the past season. A railway car is fitted up with illustrative material and equipped with a lecture force furnished by the college of agriculture and mechanic arts of the university and by the experiment station. Numerous districts were visited in this manner and very satisfactory institutes were held, the lecturers having the advantage of the material with which the car was supplied for use in demonstration. The railroads of the State cordially cooperated in the movement and the meetings were unusually well attended, as appears from a comparison with the attendance of the previous year in which 10,000 persons were reported to have been present at institutes, this year the number was increased to 25,400. No reports of the institutes are published.

MONTANA.

Population 243,329. Total number of homes 55,889. Number of farm homes 13,909. Per cent of farm homes 24.9. Approximate population in farm homes 60,588.

Director of institutes.—F. B. Linfield, Acting Secretary of the Board of Farmers' Institutes, Bozeman.

The board of administration of farmers' institutes in Montana is composed of the governor of the State, the director of the Montana Experiment Station, and the presidents of the Montana Registered Cattle Breeders' Association, the Montana Wool Growers' Association, the Montana Live Stock Association, the Montana Horticultural Society, the Montana State Board of Horticulture, the Montana Agricultural Association, and the Montana Dairyman's Association. The officers of the board consist of a president and secretary elected by the board for two years. The members of this board of administration are designated "Directors of Montana farmers' institutes and are authorized to hold institutes for the instruction of the citizens of the State in the various branches of agriculture, and to prescribe such rules and regulations as they may deem best for organizing and conducting the same." At least one institute shall be held in each county each year. The directors are authorized to designate the times

and places. The local county organizations are required to provide suitable halls, and must furnish them with light and heat and bear all necessary advertising expenses. Two thousand dollars was appropriated for the purpose of conducting institutes this year. Under a new law approved March 6, 1903, \$4,000 per annum is appropriated, and each institute held under the authority of the board shall be entitled to a sum not exceeding \$50 from the amount thus appropriated. An institute annual is authorized to be published, the cost not to exceed \$1,500 in any one year. Sixteen institutes were held during the year, consisting of 32 sessions. Six hundred persons were in attendance and 16 lecturers were upon the State force. Four of these lecturers were members of the agricultural college and station staffs and were present at 8 institutes, contributing 32 days of their time.

The rules of the board require that the State shall be divided into districts for institute purposes. The formation of local farmers' institute organizations, or farmers' clubs, in the various counties of the State is recommended. The secretary of the board is, under their rules, the superintendent of farmers' institutes and has immediate charge of all arrangements for the farmers' institute work over the State. He is required to make a report of the work of the year and the meetings held to the board. Five thousand copies of reports of the institutes are published each year and distributed

NEBRASKA.

Population 1,066,300. Total number of homes 220,947. Number of farm homes 116,854. Per cent of farm homes 52.9. Approximate population in farm homes 564,072.

Director of institutes.—E. A. Burnett, Director Agricultural Experiment Station of Nebraska, Lincoln.

Farmers' institutes in Nebraska are held under the general direction of the industrial college of the University of Nebraska and the agricultural experiment station. The university employs a superintendent of farmers' institutes, who is director of the experiment station. There is also employed an assistant superintendent who has charge of the field work.

Sixty-five institutes were held last year, consisting of 268 sessions. Twenty-three institutes were one-day, 38 two-day, and 4 three-day. The total attendance was 25,000. Thirty-three lecturers were employed upon the State institute force, and \$4,000 was appropriated for meeting the expenses of the work. The members of the agricultural college and experiment station staffs assist whenever their services are required and their duties in connection with their official positions permit. No report of the proceedings is published. The dates, places, and programmes for the institutes are arranged by the State director. The local county organizations consist of a president, secre-

tary, and executive committee, who are intrusted with the duties of securing meeting rooms and providing for the payment of the local expenses of the institute. The State lecturers are appointed by authority of the regents of the university and are assigned to the several localities by the superintendent of institutes. The institutes are advertised through the local papers, by means of posters, and by the distribution of programmes through the mail.

NEVADA.

Population 42,325. Total number of homes 11,190. Number of farm homes 2,164. Per cent of farm homes 19.3. Approximate population in farm homes 8,170.

Director of institutes.—N. E. Wilson, Vice-Director of the Agricultural Experiment Station, Reno.

The work of conducting farmers' institutes in Nevada is in charge of the State agricultural experiment station. There is no law in this State providing for the organization or conducting of institutes. Last year there were held, under the direction of the station staff, three institutes, composed of 18 sessions. Nine hundred and eighty-three persons were in attendance. Five State speakers comprised the lecture corps, all of whom were members of the agricultural experiment station staff. The total expense was \$120. The local organization consists of a local executive committee, with a permanent chairman and secretary.

The arranging of dates, places, and programmes is by the State director, after consultation with members of the local committee. The railroad companies furnish free transportation for all workers within State limits and grant reduced rates to all who attend the institutes. No report of the proceedings is published.

NEW HAMPSHIRE.

Population 411,588. Total number of homes 97,902. Number of farm homes 28,271. Per cent of farm homes 28.9. Approximate population in farm homes 118,948.

Director of institutes.—N. J. Bachelder, Secretary State Board of Agriculture, Concord.

The public statutes of New Hampshire require the secretary of the board of agriculture to "make arrangements for, give public notice of, and if possible personally attend the farmers' meetings authorized by the board." Under this general authority farmers' institutes are organized and conducted. Last season 18 one-day institutes, composed of 36 sessions, were held. Six thousand three hundred people were in attendance and 14 lecturers were upon the State corps. The total expense was \$1,000, which was apportioned from the general fund appropriated to the State board of agriculture. Local arrangements for holding institutes are made by the secretary of the board with

grange organizations, farm clubs, and agricultural and horticultural societies. Two thousand copies of reports of proceedings were published and distributed.

NEW JERSEY.

Population 1,883,069. Total number of homes 415,222. Number of farm homes 35,337. Per cent of farm homes 8.5. Approximate population in farm homes 160,111.

Director of institutes.—Franklin Dye, Secretary of State Board of Agriculture, Trenton.

The farmers' institutes in New Jersey are organized and conducted under general authority granted to the State board of agriculture by the legislature. Under the act the board is authorized to "employ suitable persons to lecture before the State board of agriculture at its annual or other meetings and in the counties of the State." The executive committee of the board has delegated the management and conduct of the institutes to its secretary. Thirty-one institutes were held last season, made up of 119 sessions. Twelve of these institutes were one-day, 18 were two-day, and 1 three-day. The total attendance was 6,850. Thirty-eight lecturers were employed during the season upon the State force, and \$2,000 was expended for meeting the expenses. No report of the proceedings is published.

Independent institutes, averaging two meetings in each of the eighteen counties, were held, with an attendance of about 50 each. The State director usually furnishes a speaker when requested to lecture before these independent or auxiliary institutes. There are no specific local organizations for institute work in the State. The director invites the members of county boards, granges, and farm clubs to aid him in the work of arranging for the county meetings. In most places the dates, places, and programmes are prepared by the State director. The local communities are expected to provide proper meeting rooms and pay all expenses for heat and light. The director attends almost all of the institutes, and in many instances takes a place regularly upon the platform as a lecturer.

NEW MEXICO.

Population 195,310. Total number of homes 46,355. Number of farm homes 13,102. Per cent of farm homes 28.3. Approximate population in farm homes 55,272.

Director of institutes.—Luther Foster, President of College of Agriculture and Mechanic Arts, and Director of the Experiment Station, Mesilla Park.

The farmers' institute work in New Mexico is under the direction of the agricultural college and experiment station. There is no specific legislation providing for the organization or control of the institute work. The expenses are met by appropriations made by the

board of regents of the College of Agriculture and Mechanic Arts and of the experiment station. Three institutes were held last year, having a total of 13 sessions. Three hundred and seventy-five persons were in attendance, and five lecturers, all members of the station staff, gave instruction at these meetings. The total expense amounted to \$125. No report of proceedings is published. The citizens in the localities where institutes are held pay all the expenses of the meetings except those incurred by the State lecturers. The advertising of the institutes is committed to the localities in which the meetings are to be held.

NEW YORK.

Population 7,268,894. Total number of homes 1,634,523. Number of farm homes 227,822. Per cent of farm homes 13.9. Approximate population in farm homes 1,010,376.

Director of institutes.—F. E. Dawley, Fayetteville.

The director of institutes is appointed by the commissioner of agriculture under authority of an act of the legislature creating the department of agriculture. The law simply provides for the appointment of the director of institutes and for the appropriation of funds to conduct them, leaving the organization and management entirely in the hands of the State institute director. Last year 312 institutes were held, made up of 1,363 sessions. One hundred and six of these institutes were one-day, 202 were two-day, and 4 were three-day. The total attendance was 138,528. Sixty-six lecturers were upon the State corps, and \$20,000 was appropriated for carrying on the work. As many as five separate corps of speakers are in the field at the same time. An annual meeting of the lecturers upon the State force has been held for the purpose of normal instruction. The director contemplates extending the course so as to continue for about two weeks, the meetings to be held at the State experiment station and at Cornell University. The State speakers in New York are all listed under the civil service, and the director reports that there has been no serious trouble from the rulings of the Civil Service Commission. A special effort has been made to develop institute lecturers, and the large number of efficient men now on the New York State force is evidence of the success of the director in this respect.

An annual report of institutes, amounting to 25,000 copies, was printed and the copies distributed by the State director and by members of the legislature. The local, or county, organization varies. Usually a local committee is selected by the State director to have charge of the arrangements for holding the county meetings. The dates, places, and programmes are arranged by the director. Each locality is required to provide a hall free of expense. The State pays the expenses for advertising and also for lighting and heating of the hall.

The director frequently furnishes speakers for independent institutes that are held under the auspices of granges, farm clubs, or agricultural societies. The attendance at these independent institutes last year is reported as 2,320.

NORTH CAROLINA.

Population 1,893,810. Total number of homes 370,072. Number of farm homes 223,831. Per cent of farm homes 60.5. Approximate population in farm homes 1,145,755.

Director of institutes.—S. L. Patterson, Commissioner of Agriculture, Raleigh.

By act of assembly it is made the duty of the commissioner of agriculture of North Carolina, by and with the consent and advice of the board of agriculture, "to hold farmers' institutes in the several counties of the State as frequently as may be deemed advisable in order to instruct the people in improved methods in farming, in the beneficial use of fertilizers and composts, and to ascertain the wants and necessities of the various farming communities; and may collect the papers and addresses made at these institutes and publish the same in pamphlet form, annually, for distribution among the farmers of the State. He may secure such assistants as may be necessary or beneficial in holding such institutes."

Fifteen institutes were held last year, composed of 25 sessions, and attended by 1,525 persons. Eight instructors were upon the State lecture force, five of whom were members of the agricultural college and station staffs. Representatives of these institutions attended every institute, giving in the aggregate 51 days of their time. Six hundred dollars was appropriated by the board of agriculture for defraying the expenses of the work. The commissioner of agriculture is elected by the people for a term of four years. One thousand dollars has been set aside by the board for institute purposes for the coming season.

No annual report has been published. The local organization for the counties consists of a chairman, secretary, and committee on programmes. The director holds institutes upon request of the various localities. The local expenses are provided for by the community in which the institute is held. Announcement of the dates, places, and speakers is made by publication in the newspapers and through the distribution of posters.

NORTH DAKOTA.

Population 319,146. Total number of homes 64,690. Number of farm homes 44,112. Per cent of farm homes 68.2. Approximate population in farm homes 217,657.

Director of institutes.—E. E. Kaufman, Professor of Dairying, North Dakota Agricultural College, Agricultural College.

The farmers' institute board is provided for by an act of assembly

approved March 13, 1903. The board is composed of the president of the board of trustees of the North Dakota Agricultural College, the commissioner of agriculture and labor, the director of the experiment station, the professor of agriculture and the professor of dairying of the North Dakota Agricultural College. It is made the duty of the board "to employ a director of farmers' institutes and such other lecturers as may be deemed necessary; to authorize the holding of not less than 40 institutes each year."

Nineteen institutes were held last year consisting of 67 sessions. Three institutes were one-day, and 16 were two-day. The total attendance is reported as 2,655. The number of speakers on the State lecture force is 11, and \$1,500 was appropriated for carrying on the work. Four of the State speakers were members of the agricultural college and experiment station staffs. Representatives of these institutes were present at 6 institutes, contributing 14 days of time. The proceedings are published in an institute annual, of which 10,000 were distributed at subsequent institute meetings and through the mail. The institute board appoints all State lecturers. An institute committee in each county is selected by the State institute board to look after the advertising and make such special arrangements as are necessary for the successful conduct of the meetings. The dates, places, and programmes are all arranged by the State director, and notices of meetings are published about four weeks in advance. The State director is appointed by the State farmers' institute board for one season. A number of independent institutes were held by local farmers' societies with an estimated attendance of 225. The institute meetings are advertised by means of large posters, through the publication of the programmes by local newspapers, and by postal-card invitations sent out through the mail. The act of the legislature of 1903 increased the appropriation for institute purposes to \$8,000 per year.

OHIO.

Population 4,157,545. Total number of homes 944,433. Number of farm homes 280,068. Per cent of farm homes 29.7. Approximate population in farm homes 1,237,790.

Director of institutes.—W. W. Miller, Secretary State Board of Agriculture, Columbus.

The farmers' institute work in Ohio is organized under the provisions of an act passed April 26, 1890, and amended April 27, 1896. Under this act whenever "twenty or more persons, residents of any county in the State, organize themselves into a farmers' institute society, adopt a constitution and by-laws agreeable to rules and regulations furnished by the State board of agriculture; and when such society shall have elected proper officers and performed such other

acts as may be required by the rules of the State board of agriculture, such society shall be deemed a body corporate." Not more than four farmers' institute societies in any county are permitted to hold annual meetings under the auspices of the State board of agriculture. The secretary of the State board of agriculture has charge of the farmers' institute work under the general direction of the board. Section 3 of the act provides for the maintenance of farmers' institutes through the levy of a direct tax. Ohio is the only State that has adopted this method of institute support. The section is as follows:

When a society organized under the provisions of this act shall have held an annual farmers' institute meeting in accordance with the rules of the State board of agriculture, the secretary of said board shall issue certificates, one to the president of the farmers' institute society and one to the president of the State board of agriculture, setting forth these facts, and on the presentation of these certificates to the county auditor, he shall each year draw orders on the treasurer of the county as follows: Based on the last previous national census, a sum equal to three mills for each inhabitant of the county in favor of the president of the State board of agriculture and a sum equal to three mills for each inhabitant of the county in favor of the president of the farmers' institute society, where but one society is organized; but in counties where there are more than one farmers' institute society organized under the provisions of this act and holding meetings under the auspices and by the direction of the State board of agriculture, the said three mills for each inhabitant shall be equally apportioned among such societies, and warrants in the proper amounts issued to the respective presidents, and the treasurer of the county shall pay the same from the county fund: *Provided*, That in no county shall the total annual sum exceed two hundred and fifty dollars: *And provided further*, That the payment to any institute society shall not exceed the expense, as per detailed statement, provided in section four of this act.

The act, it will be seen, provides permanent county institute organization and secures to each a substantial fund for support. The State board of agriculture, under rules which it is authorized to prescribe, gives specific instructions for the formation of local societies and directs how reports shall be made out, and directs the details to be observed in conducting their institute meetings. The State lecturers are required to devote their time and efforts to the discussion of such subjects as are designated by the institute law, namely, "farming, stock raising, fruit culture, and all branches of business connected with the industry of agriculture."

Two hundred and sixty-three institutes were held last year consisting of 1,250 sessions. All of these were two-day institutes. Eighty-one thousand seven hundred and fifty-two persons were in attendance. The State teaching force consisted of 29 members and the total expense incurred was \$16,981. Ten thousand copies of reports of the proceedings were published and distributed. All of the local expenses are met by the counties from their portion of the per capita tax. The dates and places for institutes are arranged by the State director, and the programmes are submitted to him by local societies

for approval. The dates, places, and speakers are announced about forty days in advance of December 1, which is the beginning of the institute season. The institutes are advertised locally by the county societies. Twenty-eight independent institutes were held during the year by local organizations. The attendance reported was 8,681.

OKLAHOMA.

Population 398,331. Total number of homes 86,908. Number of farm homes 63,094. Per cent of farm homes 72.6. Approximate population in farm homes 289,188.

Director of institutes.—J. B. Thoburn, Secretary Board of Agriculture, Guthrie.

The formation of a State board of agriculture, consisting of six members and the governor, who is a member *ex officio*, is authorized under a recent act of the Territorial legislature. The six members of this board are elected by delegates from county institutes, whose organization is provided for in the act. Wherever not less than fifteen farmers, residents in one county, shall apply to the secretary of the Territory he is required to issue a charter of incorporation and the organization shall thereafter be known as the county farmers' institute for such county. These county institutes are required to hold an annual meeting at the county seat, at which matters pertaining to agriculture shall be discussed and one delegate be elected to attend the annual meeting of the board of agriculture. These delegates at their annual meeting elect two members of the State board of agriculture, whose terms are for three years, and the law provides that this board "shall have supervision of the county farmers' institute system." The board elects its secretary and assigns his duties, one of which is the management of the farmers' institutes.

Last year 29 institutes were held: Twenty-three one-day, 5 two-day, and 1 three-day. There were 36 sessions. One thousand dollars was appropriated for conducting the work. Six speakers were upon the institute force, all members of the agricultural college and experiment station staffs, and contributing twenty days of their time. The local expenses of the institutes are provided for by the county institute societies. The dates of institutes are fixed by the county organizations at their annual meetings, and they also assist the State director in preparing programmes. No report of the institute proceedings is published.

OREGON.

Population 413,536. Total number of homes 91,214. Number of farm homes 36,156. Per cent of farm homes 39.6. Approximate population in farm homes 163,760.

Director of institutes.—James Withycombe, Director Agricultural Experiment Station, Corvallis.

Oregon has no law regarding farmers' institutes. Those that are

held are under the direction of the State agricultural college and experiment station, and are voluntary on the part of these institutions. Last year 20 institutes were held, ten one-day and ten two-day, the total number of sessions being 60. Four thousand persons were in attendance. There were six lecturers upon the State force, all of whom were from the college and experiment station staffs. They contributed in the aggregate 240 days of time. The sum of \$300 was expended in carrying on the work. No report of proceedings is published. The sum of \$1,000 has been appropriated for institute purposes for the coming year. There is no regular form of organization for the several counties. The director arranges the dates and places after consultation with the localities desiring institutes.

PENNSYLVANIA.

Population 6,302,115. Total number of homes 1,320,025. Number of farm homes 225,565. Per cent of farm homes 17.1. Approximate population in farm homes 1,077,661.

Director of institutes.—A. L. Martin, Deputy Secretary of Agriculture, Harrisburg.

Under the Pennsylvania law the deputy secretary of agriculture, who is appointed by the governor for a term of four years, is also director of farmers' institutes. He is required to "arrange them in such manner as to time and places of holding the same as to secure the greatest economy and efficiency of service, and to this end he shall, in each county where such institutes are to be held, confer and advise with the local member of the State board of agriculture, together with representatives duly appointed by each county agricultural, horticultural, and other like organizations, with reference to the appointment of speakers and other local arrangements."

The institutes are supported by biennial appropriations by the legislature to the department of agriculture. The number of institutes held last year were 327, consisting of 831 sessions. Forty-nine of these institutes were one-day, 277 two-day, and 1 three-day. There were 58 lecturers upon the State force. The amount appropriated for the support of the institutes was \$15,000. Partial reports are published in the annual report of the department. Thirty-one thousand six hundred copies of this report are published and distributed annually. The Pennsylvania State College and the Agricultural Experiment Station were represented on the institute lecture force by four members, who contributed in the aggregate 108 days of their time and attended 58 institutes. The local organization consists of a county chairman, who is usually the member of the State board of agriculture elected by the county agricultural society, and one representative from each of the other county agricultural organizations. All of the expenses of the institute work, including the local expenses in the several counties, are paid out of the State appropriation. The

State director fixes the dates and the county committees select the places and prepare the programmes. About 75 independent institutes were held last year by farmers' clubs, granges, and county agricultural societies. The State is divided into five sections for institute purposes, and the institute director furnishes three lecturers for each section.

A feature of the work in this State has been the prescribing of one or two important topics, requiring them to be placed upon every programme for discussion throughout the State. The training of institute lecturers so as to increase the number of efficient instructors in the institute work is made an important feature by the State director.

PORTO RICO.

Farmers' institutes have not yet been organized in Porto Rico.

RHODE ISLAND.

Population 428,556. Total number of homes 94,179. Number of farm homes 5,638. Per cent of farm homes 6. Approximate population in farm homes 25,713.

Director of institutes.—John G. Clarke, Secretary State Board of Agriculture, Providence.

Farmers' institutes in Rhode Island are conducted under authority granted by the general assembly in an act passed May 19, 1892, section 4 of which is as follows: "The board shall hold one agricultural institute in each county annually, either independently or in connection with any society or association, or other organization devoted to the same general objects, and may hold as many more as it shall deem expedient, and shall, as far as practicable, encourage State and local associations and societies in the interest of agriculture." The secretary of the State board of agriculture is charged with the duty of arranging for and holding institutes, the expenses of which are paid by the board out of an annual appropriation of \$15,000. One institute was held in this State, with a total attendance of 20. One lecturer was upon the State force. The total expense was \$44.

SOUTH CAROLINA.

Population 1,340,316. Total number of homes 269,864. Number of farm homes 152,993. Per cent of farm homes 56.7. Approximate population in farm homes 759,959.

Director of institutes.—J. S. Newman, Director Agricultural Experiment Station, Clemson College.

There is no special law in this State authorizing the holding of farmers' institutes. Institutes, however, are held under authority granted by the board of trustees of Clemson Agricultural College. A committee of this board makes out the programme for the year and appoints an officer to take charge of the work of conducting the meet-

ings. Thirty-one institutes were held with an equal number of sessions. The total attendance was 8,690. Eleven lecturers were on the State force, and the total expense of the institutes was \$1,000. Eight members of the college and station staffs contributed thirty days of time to institute work. The programme for each institute is arranged at the college before the season begins, and the college pays the entire expenses connected with the meetings.

Nineteen institutes for negroes were conducted by the Colored Normal Industrial, Agricultural, and Mechanical College under the direction of President Thomas E. Miller. The attendance aggregated 5,700, and thirty-five days of the time of the college staff were given to the work. The expense of the institute amounted to \$150. No report of the proceedings was published.

SOUTH DAKOTA.

Population 401,570. Total number of homes 83,536. Number of farm homes 51,937. Per cent of farm homes 62.2. Approximate population in farm homes 249,776.

There has been no legislation in South Dakota relating to farmers' institutes and no institutes were held during the past year.

TENNESSEE.

Population 2,020,615. Total number of homes 402,536. Number of farm homes 226,027. Per cent of farm homes 56.2. Approximate population in farm homes 1,135,585.

Director of institutes.—W. W. Ogilvie, Commissioner of Agriculture, Nashville.

Tennessee has no special law respecting farmers' institutes. An appropriation is made to the department of agriculture by the legislature to be used by the commissioner for institute purposes. The commissioner has complete control of the work, selects the lecturers, arranges the programmes, and decides the places and times for holding the meetings. Forty institutes were held last year at a cost of \$2,500. Seven members of the agricultural college and station staffs contributed 125 days of their time in giving instruction at institute meetings. Ten thousand persons are reported as having been in attendance.

The death of the former commissioner, who had charge of the institute work during the past season, has made it impossible to secure full statistical data. A general farmers' institute was held at the State Agricultural and Mechanical College at Knoxville, June 23 to 26, at which there were estimated to be about 1,200 farmers, mostly from eastern Tennessee. The meetings were addressed by members of the agricultural college and experiment station staffs, as well as by lecturers secured from other States. The appropriation for institute purposes for the coming year has been increased to \$5,000.

TEXAS.

Population 3,048,710. Total number of homes 589,291. Number of farm homes 341,889. Per cent of farm homes 58. Approximate population in farm homes 1,768,251.

Director of institutes.—R. L. Bennett, Agricultural and Mechanical College, College Station.

The legislature at its last session made an appropriation for the salary of a superintendent of farmers' institutes. The board of directors of the college has also set aside out of its general funds an amount sufficient to pay the traveling expenses of the superintendent. Until the present year the farmers' institutes were held under an organization known as the Texas Farmers' Institutes. The expenses were met by an agricultural paper that paid the salary of a director of institutes and such other expenses as were involved in carrying on the work. Sixty-four institutes were held during the year, made up of 180 sessions. Five thousand three hundred and seventy-six persons were in attendance and the total cost was \$2,100.

Local institutes have been organized in many of the counties of the State. The director, however, with but few exceptions, arranges the dates, places, and programmes for institute meetings. All of the local expenses are met by the citizens of the community in which the institutes are held, including the entertainment of the State lecturers. No report of proceedings is published.

There has been organized in this State the Farmers' Boys Progressive League, intended to reach the boys and girls out upon the farms, and to assist and interest them in the higher forms of agricultural life and practice. Any boy or girl between the ages of 14 and 20, living on the farms or ranches of the southwest, can become a member and will be entitled to certain privileges which the constitution of the league provides. For the present they are engaged in cultivating crops, the seeds of which were furnished by the Texas Farmers' Congress. A report of their work is to be made to the county farmers' institute and prizes are offered for products that are specially meritorious.

UTAH.

Population 276,749. Total number of homes 56,196. Number of farm homes 19,529. Per cent of farm homes 34.8. Approximate population in farm homes 96,308.

Director of institutes.—John A. Widsøe, Director Agricultural Experiment Station, Logan.

Farmers' institutes in Utah are by law under the direction of the trustees of the agricultural college, who are "authorized and required to hold institutes." There must be held at least one institute in each county during each school year, at such times and such places as the

trustees and faculty of the agricultural college may direct. The sum of \$1,500 is appropriated for institute purposes, to be expended by the board of trustees of the college. Under the provisions of this act it is made the duty of those conducting institutes to encourage and assist in the organization of local agricultural societies. The course of instruction must be so arranged as to "present to those in attendance the results of the most recent investigations in theoretical and practical agriculture."

Forty institutes were held during the year, consisting of forty sessions. Three thousand two hundred people were in attendance. Ten lecturers were upon the State institute force, all of whom were members of the college faculty or experiment station staff. Five thousand copies of the reports of proceedings are printed and distributed. A committee of the faculty, under the direction of the president, arranged for all institute work. The dates, places, and programmes are fixed by this committee. All of the local expenses incurred in holding meetings are paid out of the State appropriation.

VERMONT.

Population 343,641. Total number of homes 81,462. Number of farm homes 32,871. Per cent of farm homes 40.4. Approximate population in farm homes 138,830.

Director of institutes.—C. J. Bell, Secretary State Board of Agriculture, East Hardwick.

The farmers' institute work of Vermont is under the control of the State board of agriculture. This board is composed of the governor, the president of the University of Vermont and State agricultural college, and three other persons appointed by the governor. They hold office for two years. The board is required to "hold one meeting in each county annually, and others if deemed expedient, and may employ lecturers, essayists, or other aid in conducting said meetings, managing its affairs generally, and discharging its duties. At such meetings it shall present subjects for discussion and, among other topics, forestry, tree planting, roads, and road making."

Forty-one institutes were held last year, consisting of 108 sessions. Sixteen thousand four hundred persons were in attendance. Twenty-six lecturers constituted the State force, and \$5,000 was appropriated for meeting the expenses. The board publishes annually 3,000 copies of its report, which includes the proceedings of the farmers' institute. The dates, places, and programmes for institutes are arranged by the State director. The free use of hall is required to be provided by the community, the State board defraying the other local expenses. A number of independent institutes were held, having an estimated attendance of about 500.

VIRGINIA.

Population 1,854,184. Total number of homes 364,517. Number of farm homes 170,412. Per cent of farm homes 46.8. Approximate population in farm homes 867,758.

Director of institutes.—G. W. Koiner, Commissioner of Agriculture, Richmond.

The board of agriculture of the State of Virginia is required to hold "farmers' institutes at such times and at such places throughout the State as it may deem necessary for the advancement of agricultural knowledge and the improvement of agricultural methods and practices, and publish and disburse such papers and addresses read or made at these institutes as promise to be of value to the farming interests."

The duty of arranging for and conducting farmers' institutes is placed in the hands of the secretary of the board. Last year 72 institutes were held, composed of 144 sessions, attended by 18,000 persons. Three lecturers were upon the State force. The agricultural college and station staffs attended four institutes and contributed eight days of time. All of the expenses of the institutes are borne by the department of agriculture. An appropriation of \$3,500 has been made by the State board for the expenses of institutes during the coming year.

WASHINGTON.

Population 518,103. Total number of homes 113,086. Number of farm homes 33,931. Per cent of farm homes 30. Approximate population in farm homes 155,430.

Director of institutes.—E. A. Bryan, President Washington Agricultural College, Pullman.

The law of the State of Washington, in defining the purposes of the Washington Agricultural College and School of Science declares that "one of the objects of the State college shall be to hold farmers' institutes at such times and places and under such regulations as the board of regents may determine." An act of the legislature of 1903 requires that "at least one institute shall be held in each county in each year."

The sum of \$2,500 is appropriated for institute purposes. Twelve institutes were held during the past season, attended by 1,800 people. Three members of the agricultural college and experiment station staffs were upon the State lecture course and contributed thirty days of their time.

WEST VIRGINIA.

Population 958,800. Total number of homes 186,291. Number of farm homes 94,566. Per cent of farm homes 50.8. Approximate population in farm homes 487,070.

Director of institutes.—J. B. Garvin, Assistant Secretary of the Board of Agriculture, Charleston.

The law of West Virginia places the control of the farmers' institutes in the hands of the State board of agriculture. Under this act

the board is required to "promote and encourage as far as practicable the holding of farmers' institutes, the organization of agricultural and horticultural societies and other associations in the interest of agriculture in the several counties of the State. * * *" It is directed to "hold farmers' institutes for the instruction of the farmers of the State in the various branches of agriculture. Such institutes shall be held at such times and places in each year as the said board may direct. The said board shall make such orders and regulations as it may deem proper for organizing and conducting such institutes and may employ an agent or agents to perform such work in connection therewith as they may deem best." The course of instruction in such institutes shall be so "arranged as to present to those in attendance the results of the most recent investigations in theoretical and practical farming." One hundred and fifty-eight institutes were held last year; 23 were one-day, 135 were two-day, together comprising 632 sessions. Fifteen thousand seven hundred and fifty persons were reported in attendance. Sixteen lecturers were upon the State force, four of whom were members of the agricultural college and experiment station staffs, who attended 17 institutes and contributed forty days of their time. Five thousand four hundred and fifty-one dollars was appropriated for institute work.

There is no law requiring the formation of local institute associations, but the board of agriculture has had prepared a set of by-laws which they recommend to local communities for adoption for the purpose of securing a local farmers' institute society in every county in the State. The director of institutes is appointed by the State board of agriculture for a period of two years. The board arranges the dates of the institutes and assigns two of its members to be present at each. The entire expense of the institutes is paid out of the appropriation made to the State board of agriculture. The reports of the proceedings of the several institutes are required to be sent in to the secretary of the board and are printed in an agricultural periodical issued under the direction of the State board of agriculture.

WISCONSIN.

Population 2,069,042. Total number of homes 436,063. Number of farm homes 169,531. Per cent of farm homes 39.8. Approximate population in farm homes 823,478.

Director of institutes.—George McKerrow, Madison.

The board of regents of the State University is authorized by the law of Wisconsin to "hold institutes for the instruction of citizens of this State in the various branches of agriculture. Such institutes shall be held at such times and at such places as said board may direct. The said board shall make such rules and regulations as it may deem

proper for organizing and conducting such institutes, and may employ an agent or agents to perform such work in connection therewith as they may deem best."

One hundred and twenty institutes were held during the year. Twenty were one-day institutes, 99 were two-day, and 1 three-day, aggregating 566 sessions. The total number reported in attendance was 55,000. Twenty-two lecturers were upon the State force, two of whom were members of the agricultural college and experiment station staffs, who contributed four days of time. The amount appropriated for institute expenses was \$12,000. Sixty thousand copies of the farmers' institute bulletin, containing the proceedings of the institutes, were published and distributed. The local expenses of the institutes are provided for by the citizens of the community in which the institute is held. The meetings are placed upon request of the various localities. Petitions are sent in to the director of institutes and, through these, meetings are granted in the discretion of the State director. Fifteen thousand posters and 45,000 programmes of the meetings were sent out from the State office last year, as well as notices of institute meetings to all the papers in the section in which the meetings were held. The arranging of the dates, places, and programmes is in the hands of the institute director, and announcements of the times, places, and speakers are made about one month in advance of the institute season. The special topics for discussion last year were live stock and dairying. The institute director is elected by the board of regents of the university, nominated by the president of the university and dean of the agricultural college, and recommended by the farm committee. He takes a place regularly on the programme as a lecturer, and is in the field during the entire season in which institutes are held.

WYOMING.

Population 92,531. Total number of homes 20,116. Number of farm homes 5,939. Per cent of farm homes 29.5. Approximate population in farm homes 27,296.

Director of institutes.—Charles W. Lewis, President of the University of Wyoming, Laramie.

Farmers' institutes have not been organized in Wyoming, and there is no legislation providing for their organization or support. The faculty of the State University and the experiment station staff have undertaken to conduct a series of institute meetings during the coming year.

Number of institutes held and the approximate attendance during the year ended June 30, 1903.

States and Territories.	Number of one-day institutes.	Number of two-day institutes.	Number of three or more days institutes.	Total.	Total number of sessions.	Total at- tendance.
Alabama.....	22			22	50	2,618
Arizona.....				2	20	1,000
California.....	12	45	3	60	254	20,000
Colorado.....	6	2	2	10	20	1,300
Connecticut.....	8		1	9	25	4,000
Delaware.....	21	7		28	67	4,800
Florida.....	20	1		21	42	2,900
Georgia.....	14	1		15	32	3,500
Hawaii.....	4			4	4	100
Idaho.....	5	12		17	75	2,550
Illinois.....		68	40	108		42,876
Indiana.....	3	178		181	858	73,653
Iowa.....		50	14	64	348	17,750
Kansas.....	82	10		92	204	38,085
Kentucky.....	2	6		8		2,000
Louisiana.....	48		2	50	134	13,245
Maine.....	40			40	83	5,846
Maryland.....	22	18		40	116	11,222
Massachusetts.....	120			120	154	12,487
Michigan.....	213	70	1	284	885	53,037
Minnesota.....	85	15		100	238	35,171
Mississippi.....	56	2		58	122	10,000
Missouri.....	50	76	1	127		25,400
Montana.....	16			16	32	600
Nebraska.....	23	38	4	65	268	25,000
Nevada.....		3		3	18	983
New Hampshire.....	18			18	36	6,300
New Jersey.....	12	18	1	31	119	6,850
New Mexico.....	1	1	1	3	13	375
New York.....	106	202	4	312	1,363	138,528
North Carolina.....	15			15	25	1,525
North Dakota.....	3	16		19	67	2,655
Ohio.....		263		263	1,250	81,752
Oklahoma.....	23	5	1	29	36	
Oregon.....	10	10		20	60	4,000
Pennsylvania.....	49	277	1	327	831	112,550
Rhode Island.....	1			1	1	20
South Carolina.....	50			50	50	5,700
Tennessee.....				40		8,690
Texas.....				64	180	10,000
Utah.....	40			40	40	5,376
Vermont.....	41			41	108	3,200
Virginia.....	72			72	144	16,400
Washington.....	3	9		12		18,000
West Virginia.....	23	135		158	632	1,800
Wisconsin.....	20	99	1	120	566	15,750
Total.....	1,359	1,637	77	3,179	9,570	55,000
						904,654

Financial statistics of the farmers' institutes for the year ended June 30, 1903.

States and Territories.	Funds appropriated for institutes.		Cost.		Appropriations for the season 1903-4.
	State.	College and other funds.	Total cost.	Cost per session.	
Alabama	\$600.00		\$600.00	\$12.00	\$800.00
Arizona		\$60.00	60.00	3.00	2,700.00
California		4,000.00	3,400.00	56.00	6,000.00
Colorado		385.00	385.00	19.00	
Connecticut	700.00		700.00	28.00	700.00
Delaware	700.00	100.00	800.00	12.00	600.00
Florida	2,500.00		2,500.00	38.00	2,500.00
Georgia		1,000.00	1,000.00	22.00	1,000.00
Hawaii		35.00	35.00	9.00	150.00
Idaho	1,000.00		1,000.00	36.00	1,000.00
Illinois	18,150.00		18,150.00		19,650.00
Indiana	10,000.00			10.50	10,000.00
Iowa	7,425.00		5,000.00	14.00	7,425.00
Kansas	2,000.00		2,000.00	10.00	2,000.00
Louisiana	2,000.00		2,000.00	15.00	2,000.00
Maine	3,000.00		3,000.00	36.00	3,000.00
Maryland	4,000.00		4,000.00	34.50	4,000.00
Massachusetts	2,000.00		1,717.00	16.35	2,700.00
Michigan	7,500.00		5,838.00	6.59	7,500.00
Minnesota	16,500.00		16,500.00	50.00	18,000.00
Mississippi	1,500.00		1,500.00	25.86	1,500.00
Missouri	4,000.00		4,000.00	32.00	5,000.00
Montana	2,000.00		2,631.00	82.00	4,000.00
Nebraska	4,000.00		4,000.00	15.00	6,000.00
Nevada		120.00	120.00	6.66	1,000.00
New Hampshire	1,000.00		1,000.00	25.00	
New Jersey	2,000.00		1,800.00	15.00	2,000.00
New Mexico		125.00	125.00	9.60	
New York	20,000.00		20,000.00	14.73	20,000.00
North Carolina	600.00		600.00	24.00	1,000.00
North Dakota	1,500.00		1,158.00	17.30	4,000.00
Ohio	16,981.00		16,981.00	13.58	16,750.00
Oklahoma	1,000.00		1,000.00		
Oregon		300.00		5.00	1,000.00
Pennsylvania	15,000.00		15,000.00	18.00	17,500.00
Rhode Island	44.00		44.00	44.00	
South Carolina		1,120.00	1,120.00	32.00	1,000.00
Tennessee	2,500.00		2,500.00		5,000.00
Texas		2,100.00	2,100.00	11.66	3,000.00
Utah	1,500.00		1,500.00	37.50	1,500.00
Vermont	5,000.00		2,907.00	26.70	5,000.00
Virginia					3,500.00
Washington	2,500.00		2,500.00		2,500.00
West Virginia	5,451.00		5,451.00	34.50	6,000.00
Wisconsin	12,000.00		12,000.00	15.00	12,000.00
Total	176,651.00	9,345.00	179,022.00	933.03	210,975.00

Comparative statement of farmers' institutes.

States and Territories.	Appropriations.		Number of sessions.	Number of institutes.		Attendance.	
	1901-2.	1902-3.		1901-2.	1902-3.	1901-2.	1902-3.
Alabama	\$600	\$600	50	24	22	2,616	2,618
Arizona		60	20	2	2	1,350	1,000
California	4,000	4,000	254	63	60	20,000	20,000
Colorado		385	20	15	10		1,300
Connecticut		700	25	12	9	5,000	4,000
Delaware	600	800	67	15	28	3,055	4,800
Florida	2,500	2,500	42	22	21	3,300	2,900
Georgia		1,000	32		15		3,500
Hawaii		35	4	4		180	160
Idaho	500	1,000	75	50	17	17,000	2,550
Illinois	18,150	18,150		110	108	39,187	42,876
Indiana	10,000	10,000	858	201	181	40,000	73,653
Iowa	7,425	7,425	348	65	64	6,500	17,750
Kansas	2,000	2,000	204	102	92	32,456	38,085
Kentucky		1,200			8	1,600	2,000
Louisiana	2,000	2,000	134	38	50	7,500	13,245
Maine	3,500	3,000	83	37	40	5,920	5,846
Maryland	4,000	4,000	116	36	40	1,500	11,222
Massachusetts		2,000	154	128	120	2,176	12,487
Michigan	7,500	7,500	885	255	284	101,000	53,087
Minnesota	16,500	16,500	238	69	100	27,205	35,171
Mississippi	1,500	1,500	122	40	58	8,000	10,000
Missouri	4,000	4,000		104	127	10,000	25,400
Montana	2,000	2,000	32	17	16	1,200	600
Nebraska	4,000	4,000	268	86	65	25,800	25,000
Nevada		120	18		3		983
New Hampshire		1,000	36	40	18	4,000	6,300
New Jersey	600	2,000	119	17	31	5,000	6,850
New Mexico		125	13		3		375
New York	20,000	20,000	1,363	269	312	94,688	138,528
North Carolina	322	600	25	17	15	1,700	1,525
North Dakota	1,500	1,500	67	27	19	9,967	2,655
Ohio	16,784	16,981	1,250	278	263	94,655	81,752
Oklahoma		1,000	36	11	29	1,150	
Oregon		300	60	19	20	3,335	4,000
Pennsylvania	15,000	15,000	831	189	327	144,431	112,550
Rhode Island		44	1	1		30	20
South Carolina	1,051	1,150	50	31	50	10,100	14,390
Tennessee	2,016	2,500			40		10,000
Texas		2,100	180		64		5,376
Utah	1,500	1,500	40	44	40		3,200
Vermont	4,000	5,000	108	50	41	10,000	16,400
Virginia			144	47	72	14,100	18,000
Washington		2,500		31	12	1,500	1,800
West Virginia	5,000	5,451	632	75	158	15,000	15,750
Wisconsin	12,000	12,000	566	122	120	48,800	55,000
Total	170,548	187,226	9,570	2,764	3,179	819,995	904,654

Number of lecturers employed by the State directors of farmers' institutes during the year ended June 30, 1903.

States and Territories.	Total number of lecturers on the State force.	Number of members of agricultural college and experiment station staffs engaged in institute work.	Number of institutes attended by members of the agricultural college and experiment station staffs.	Number of days contributed to the institute work by the agricultural college and experiment station staffs.	Total number of days of institutes held during the year.	Reports of proceedings.	
						Published.	Number of copies.
Alabama	11	8	22	52	22	No.....	
Arizona	4	1	2	22	16	No.....	
California	23	13	60	131	111	Yes....	10,000
Colorado	9	9	10	65	16	No.....	
Connecticut	21				11	Yes....	5,000
Delaware	19	4	10	15	35	No.....	
Florida	22	2	21	30	22	Yes....	5,000
Georgia	8	9	13	16	16	No.....	
Hawaii			4		4	No.....	
Idaho	9	6	17	60	29	Yes....	6,000
Illinois	84	7	13	23	256	Yes....	
Indiana	39				359	Yes....	600
Iowa					142	No.....	
Kansas	16	19	90	200	102	No.....	
Kentucky	11	3	5	15	11		10,000
Louisiana	13				54		3,500
Maine	9				40	Yes....	6,000
Maryland	7	7	40	56	58	No.....	
Massachusetts	68	8	11	28	120	No.....	
Michigan	97				356	Yes....	8,000
Minnesota	13	1	19	19	115	Yes....	30,000
Mississippi	15	9	58	25	60	Yes....	18,000
Missouri	31	10	127	120	205	No.....	
Montana	16	4	8	32	16	Yes....	5,000
Nebraska	33				111	No.....	
Nevada	5	5	3	9	6	No.....	
New Hampshire	14				18	Yes....	2,000
New Jersey	38				51	No.....	
New Mexico	5	5	3	43	6	No.....	
New York	66				522	Yes....	25,000
North Carolina	8	5	15	51	15	No.....	
North Dakota	11	4	6	14	35	Yes....	10,000
Ohio	29				526	Yes....	10,000
Oklahoma	6	6	7	20	36		
Oregon	6	6	20	240	30	No.....	
Pennsylvania	58	4	58	108	606	Yes....	31,600
Rhode Island	1				1	Yes....	
South Carolina	12	9	31	65	50	No.....	
Tennessee	7	7	40	125			
Texas						No.....	
Utah	10	10			40	Yes....	5,000
Vermont	26				41	Yes....	3,000
Virginia	3	3	4	8	72		
Washington	3	3	12	30	21		
West Virginia	16	4	17	40	293	Yes....	
Wisconsin	22	2	3	4	221	Yes....	60,000
Total	924	196	752	1,666	4,880		253,700

DEVELOPMENT OF THE TEXT-BOOK OF AGRICULTURE IN NORTH AMERICA.^a

By L. H. BAILEY,

Director of the College of Agriculture and Agricultural Experiment Station of Cornell University.

A century and a half ago the ancients were still dominant authorities in agriculture. The first great application of scientific teaching to agriculture, at least in English, was Tull's Horse-Hoeing Husbandry, 1733, in which an attempt was made to improve tillage by expounding what were conceived to be its underlying principles and results. The scientific spirit of inquiry grew slowly and steadily; but it was not until the birth of the science of agricultural chemistry in the early years of the eighteenth century that great progress was made in applying science to farming. Davy, Liebig, and Boussingault, representing three nationalities, are the prominent names in this early field. The principles of chemistry as applied to farming were conceived to be fundamental concepts of a rational agriculture. They afforded a central idea around which all other agricultural questions could be crystallized. The long-hoped-for science of agriculture had come.

In the ultimate analysis of the text-books of agriculture one finds two contrasting and conflicting types of ideas—the idea of science and the idea of business or practice. Those who conceive science to be the fundamental and controlling idea in farming start the book with discussions of groundwork of science—chemistry, plant life, physics, meteorology. Most of the older books and many of the newer ones are of this type. Those who conceive business or practice to be the unit in agriculture start the book with farm management as explained and aided by science. The former system is applied science and it usually starts with heat, air, elements, chemical action, or physiology; the latter system is scientific explanation and advice and starts with soils, plants, or animals. One emphasizes the standpoint of the student, the other the standpoint of the farmer. One begins in the laboratory, the other in the field. The applied-science

^a An article under this title I contributed to Book Reviews, 7 (1899), No. 2, pp. 43-53. The present paper is based on that article, but is greatly extended.

book may make its theme either physical science or biological science. It usually chooses the former, particularly chemistry. The early idea was to combine science with practice. The present idea is to make practice scientific from the beginning.

There is a third type of text-book in which the distinctions between science and farm management are not clearly apprehended, and the work becomes a compound of the two main-type ideas.

Considered as an industry, agriculture is manufacturing, buying, and selling. It is business. But unlike most other businesses, the operator is producer of the raw material as well as dealer in the products. In order to produce his wares to the best advantage he must know much of the principles in accordance with which the most successful production must proceed. In other words, he must know much of the sciences on which agriculture is based, as physics, chemistry, botany, and other sciences. But he should never forget that the practice of agriculture is an art and not a science.

These remarks will suggest why it is that there is such a bewildering diversity in plan in the various text-books of agriculture. One reason why these text-books have not been more successful in accomplishing the missions for which they are designed is the fact that they look upon agriculture from the academic point of view rather than from the agricultural. Another reason is the attempt to make them "practical" by inserting specific directions for the performing of accustomed farm operations; for these directions must necessarily be of local and temporary application, whereas principles are general and abiding.

More than a dozen schoolbooks of agriculture were published in the United States prior to the passage of the land-grant college act in 1862.

The first American text-book that I know is Daniel Adams's *Agricultural Reader, Designed for the Use of Schools*, and published at Boston in 1824. The preface is dated at Mount Vernon, N. H., October 23, 1824. It is a duodecimo leather-bound book of 264 pages, containing a great number of short unrelated articles on agricultural practice and kindred topics. The preface records that "The design of a publication of this nature was formed as early as the year 1821; and it was a satisfaction, while in the prosecution of it, to perceive that the occasion for such a publication already begins to be felt." This reference, as explained in a footnote, is to the report of a committee on crops of the Rockingham Agricultural Society and to the address of Theodore Sedgwick before the Berkshire Agricultural Society. Both these parties urged the necessity of a book on agriculture for schools.

The second book is apparently Taylor's *Farmer's School Book*, published in 1837 in Ithaca and Albany, N. Y. This is a 16mo of 232 pages "designed as a reading book in common schools. Children

may read and study in the schoolroom what they will practice when they become men. They now read the 'English Reader' or some other collection that they do not understand or feel any interest in, and which, the worst of all, never gives them one useful idea for the practical business of life." Taylor was editor of the monthly Common School Assistant and author of *The District School or National Education*, the latter designed "to show what our common schools now are, what they ought to be, and how the people may make them such." His *Farmer's School Book* starts out with general discussions of physical science, but soon passes into consideration of farm practice and management of specific crops. The chapter on hemp was written by Henry Clay.

The third book appears to have been Judge Buel's adaptation of General Armstrong's *Treatise on Agriculture*, 1839. There is no internal evidence that this work was designed for the schools, although it was adaptable to that use, but it was one of Harpers' School District Library. The original edition was published anonymously "by a practical farmer" in 1820 in Albany. It first ran as a serial in the *Albany Argus*, Judge Buel's paper, in 1819. Gen. John Armstrong was a soldier in the Revolution and, subsequently, United States Senator, minister to France, and Secretary of War. The book under consideration treats the subject almost wholly from the point of view of farm practice, and was an excellent treatise for its day.

Judge Buel's *Farmer's Companion, or Essays on the Principles and Practice of American Husbandry*, was published in 1839. The volume was also incorporated in *The School Library*, Vol. XVI, a series "published under the sanction of the board of education of the State of Massachusetts." The book does not appear to have been intended as a pupil's text, however.

The first distinct and professed indigenous American text-book or treatise on agriculture appears to have been Alonzo Gray's *Elements of Scientific and Practical Agriculture*, published in New York in 1842. Its chief theme is life, the "vital principle," and it is the fullest analysis of the biological type of presentation which has yet appeared in our text-book literature. It gives an excellent outline, also, of the chemical wisdom of the time. It is too technical even for our present-day rural schools.

The second real text-book treatise appears to have been Davis's *Text-Book on Agriculture*, copyrighted in 1847, but bearing the publisher's date of 1848. It is essentially a laboratory presentation of the subject. Of the eight chapters seven are concerned mostly with chemical matters, and even the eighth chapter contains little discussion of farm subjects. A long appendix is devoted to a discussion of insects injurious to vegetation. Davis's opening sentence is this: "Chemistry is that science which makes us acquainted with the com-

position and properties of bodies, and the changes which take place between the particles of matter at insensible distances from each other."

The next work is Doctor Rodgers's, of Rochester, N. Y., published in 1848, and a second edition in 1850. It is a most complete and systematic presentation of the applied-science idea, running through chemistry, geology, botany, and meteorology; and it ends with an attempt to present agricultural subjects. The highly illumined symbolic frontispiece well represents the animus of the work—a scroll reaching from the electric heavens bearing the words "Chemistry, botany, meteorology, agriculture."

A great advance was made by Professor Norton's *Elements of Scientific Agriculture*, 1850. Here there was a distinct and successful attempt to approach the subject from the agricultural view point, explaining rural practices by the applications of science. But even here the advice was very largely chemical. This was not a fault fifty years ago, but it seems to be a shortcoming when it is used in books of the present day.

In 1851 the reading-book idea, apparently dormant since Adams and Taylor's time, came forward in Rev. John L. Blake's *Lessons in Modern Farming*. This book differed widely from Taylor's, however, in the fact that it presents the subject from the literary side, whereas the earlier book presented it from the science and farm-practice side. Blake had a great intellectual interest in rural life, as evidenced by his *Farm and Fireside*, 1852, and *Farmer's Every-Day Book*, and *The Farmer at Home*.

Waring's excellent *Elements of Agriculture*, 1854, reminds one of Norton's book, although it is written more completely from the chemical point of view. The revision is dated 1868, but the general line of treatment remains the same; the author writes that "the observation and experience of the intervening years have sadly clouded some of these fancies (of the original edition), and the veil which hangs about the true theories of agriculture has grown harder to penetrate; the difficulties in the way of precise knowledge have not lessened with close acquaintance." This frank admission is the indisputable mark of the honest searcher for truth. It also suggests the inherent weakness of the attempt to teach agriculture under the guise of an exact physical science. To those who have learned to honor the name of Colonel Waring as that of a practical sanitary engineer and an efficient public servant, these references to his early labors in the agricultural field will afford a new source of pleasure.

Fox's *American Text-Book*, Detroit, 1854, has the distinction of being the first text published west of New York State. The chemical features are strong, even in the discussion of the particular crops. It goes into the methods of growing the leading crops with considerable fullness.

Nash's *Progressive Farmer*, 1857, is another chemical presentation of the subject, being even more closely confined to this view point than most of its contemporaries. Chemistry and fertilizing the land are considered to be the fundamental units.

A translation (from the German) of Albert D. Thaer's *Principles of Agriculture*, by William Shaw and Cuthbert W. Johnson, was published in New York in 1846, 1848, and 1858. It was not designed as a text-book for schools, although it was one of the volumes of the Michigan District School Library. It was an important work in its day, of 552 large pages. Thaer (1752-1828) was one of the first and greatest of agricultural teachers, experimenters, and writers.

Campbell's *Manual of Scientific and Practical Agriculture*, 1859, is a full exposition of the chemistry idea. The second half of the book is devoted to detailed instructions for growing the various crops, written from the farm-practice viewpoint. Animal industry receives liberal space.

It appeals to the writer that the books of Norton, Waring, and Emerson and Flint are the three great historic American text-books, and of these, that of Emerson and Flint seems to come nearest to the agricultural point of view. The book sets out with the chemical theme—the composition of matter, but it quickly runs into a rational elucidation of farming by means of scientific truths. It attempts to give the underlying reasons for rotation of crops, maintaining fertility of the land, the cultivation of particular classes of plants, the management of stock, and similar true agricultural problems. It stands between the old-time applied chemistry and the new-time farm practice. The second edition of the book, with no change of plan, appeared in 1885.

The agricultural colleges began to come to the fore in the sixties. Agricultural education was given an immense impetus. Of the text-books of this early period two stand out with great distinction—the ever-admirable works of Professor Johnson, of Yale, on *How Crops Grow* and *How Crops Feed*. The former first appeared in 1868, and a new edition in 1890; the latter, which is still in its original edition, appeared in 1870. These are not text-books of agriculture, but agricultural chemistries, and they are therefore not included in the following bibliography, but they gave such an impetus to the study of the subject that no sketch of American agricultural education can be complete without a mention of them. They practically held the field alone until the appearance of Storer's *Agriculture in Some of its Relations with Chemistry*, in 1887. Many books on agricultural chemistry have appeared in this country, as well as some on agricultural botany. Mention should also be made of the excellent *Elements of Agricultural Geology*, for the Schools of Kansas, by Prof. William K. Kedzie, 1877.

In the modern text-books of agriculture, the agricultural point of view has been more and more emphasized. Yet the greater part of them start out with the theme of the composition of matter, as those of James, Lupton, Thompson, Gulley, Winslow, Wallace, Voorhees, Dawson. Of the recent texts, James's *Agriculture* is the first work since Gray's, unless we except Pendleton's, which makes life, or biology, the primary theme of the treatise. Mills and Shaw's book starts out with chemistry, but, like James's, it very soon picks up the farmer's point of view and discusses farm management. Pendleton's book, which is the most minute and extended American text, presents both the biological and physical science sides, making some practical applications near the end.

From the earliest agitation of agricultural education the State has been urged, directly or indirectly, to promote the enterprise. Armstrong's original treatise, 1820, was strongly commended by the New York State board of agriculture. Norton's was a "prize essay of the New York State Agricultural Society." Emerson and Flint's was approved and recommended by the Massachusetts State board of agriculture. Ryerson's was "authorized by the council of public instruction of Ontario." James's *Scientific Manual* was published by the department of agriculture of the State of Georgia. Lupton's book was written under the auspices of the superintendent of public instruction and the commissioner of agriculture of the State of Tennessee. Gulley's *First Lessons* was written at the solicitation of the Agricultural College of Mississippi. Mills and Shaw's was "authorized by the honorable the minister of education for use in the public schools of Ontario." The plan of Voorhees's work was indorsed by the New Jersey State board of agriculture and the State Grange. Robins's edition of Dawson is published under the authority of the Protestant committee of the council of public instruction. James's book is written by the deputy minister of agriculture of Ontario. Two text-books of agriculture, one for pupils and one for teachers, have been "authorized by the advisory board of Manitoba" of the department of education; these books are *Our Canadian Prairies* and *Prairie Agriculture*.

A new motive appeared in the American text-books of agriculture in 1901, when Professor Brooks published his *Agriculture*, in three volumes, for use in a correspondence school. These volumes proceed from the chemical-composition idea, but soon take up the subject from the view point of farm practice.

The most recent tendency in text-books of agriculture is an adaptation to the elementary country schools. At last a distinctly popular movement has set in to introduce agricultural teaching into the rural schools. This movement is necessarily experimental, and the experiment will be reflected in the text-books. Two types of books will

come into use—the information-book, in which the subject-matter is to be learned and from which recitations are to be made and the nature-study book which will set pupils and teachers at work with actual things and affairs. The former will no doubt be more popular at the beginning, but the latter will have the more abiding influence, because it rests on sound pedagogical principles. In the lower grades, general nature study will no doubt prove to be the most useful method of presentation, for this is fundamental. As the grades advance, agricultural nature study can gradually be introduced.

It is probable that the most useful book, at least for the present, will be one that attempts at the same time to awaken an interest in country life and to set the pupil at the working out of specific problems. Mere problems are too “dry” to attract pupils except now and then under the inspiration of an extra good teacher. On the other hand, mere information-giving has little teaching value and is not likely to arouse any important enthusiasm for the open country and the farm. At a recent convention I heard it said, in advocacy of a certain text, that the book “would teach itself.” This is a doubtful encomium. The book that does all the work for the pupil has little abiding value.

It is probable that no one system nor one set of texts can be made to work in different parts of the Union. The introducing of agriculture into the rural schools is a very different question in the East from what it is in the West. In the West, and largely in the South, agriculture dominates public sentiment. In the East, however, agricultural sentiment is far from paramount, and in some parts it is scarcely discernible. Moreover, the theories of the relations of the university and agricultural college to the administration of public education are unlike as between some of the thirteen original States on the one hand and the States formed from the Northwest Territory and from the farther West on the other. In most parts of the East the movement is likely to originate extraneously to the public school system and to be at first of an advisory and interest-arousing character. It would seem to be a most curious anomaly that it is so difficult to introduce agricultural subjects into schools in the agricultural regions; but the wonder is explained when one remembers that school systems began with things that are extraneous to the daily life and only latterly have come to the point of putting into pedagogic form the things and activities whereby men live. It seems to be the history of the evolution of institutions that they have begun at the top and worked downward to the common and homely affairs of life. This movement for the teaching of agriculture in the schools, in other words, is the expression of the desire to put the schools in line with the activities of the people. Necessarily, the agricultural instruction will attain the greatest prominence in those regions in which agriculture itself attains to the greatest importance.

Whether it is wise to force agriculture into the common schools is a question for serious consideration. Agricultural and rural subjects should be introduced largely, if at all, for the purpose of training the mind and of putting the pupil in sympathy with the things with which he lives. If the great body of teachers of any State are not in sympathy with the teaching of agricultural subjects and have no knowledge of the *u.*, it would seem that little can be gained by forcing such subjects on them. The work must begin farther back—by arousing the pupils, the teachers, the parents. These are questions of procedure to be worked out in each great geographical region. The next few years are likely to constitute an epoch of experiment from which permanent good can not fail to come. In the meantime, we must not be impatient. The elementary text-book of agriculture will be only one factor—and sometimes a very small factor—in this new development.

Of course, the best view of the subject of text-book literature is to be had by examining the books, but there are few libraries in which all these works can be seen. Therefore, I have brought together a chronological list of all American text-books of agriculture with which I am acquainted, together with transcriptions of their tables of contents. It is an interesting and suggestive record. Efforts enough have been made, but they have fallen short of anticipations. Before text-books we need teachers, and we must appeal to the child through his interest in nature rather than technically in the farm.

The full contents are given in place of reviews, in order to show the way in which the subject is approached and handled. Most of these books are in the author's library.

CHRONOLOGICAL BIBLIOGRAPHY OF NORTH AMERICAN TEXT-BOOKS OF AGRICULTURE.

1824. DANIEL ADAMS, M. D. *The Agricultural Reader, Designed for the Use of Schools.* Boston, 1824. Published by Richardson & Lord. Pp. 264.

The book is not divided into chapters. It contains about 70 articles, mostly on agricultural practice. There are a few poems; also a glossary. The book opens with an "explanation of terms," and it is designed that the greater part of these explanations be committed to memory.

1837. J. ORVILLE TAYLOR. *The Farmer's School Book.* Published at the "Common School Depository," Albany; and by Mack, Andrus & Woodruff, Ithaca. Pp. 232.

Introduction. Chapter I, Chemistry—General Principles; Chapter II, Caloric; Chapter III, Oxygen; Chapter IV, Nitrogen; Chapter V, Atmosphere; Chapter VI, Carbon—Carbonic Acid; Chapter VII, Light—Electricity; Chapter VIII, Hydrogen; Chapter IX, Water; Chapter X, The Earth; Chapter XI, How Tillable Lands are Made; Chapter XII, The Composition of Arable Lands; Chapter XIII, Vegetable Nutriment; Chapter XIV, Properties of Mixed Earths and Their Culti-

vation; Chapter XV, The Nature of Manures—Varieties; Chapter XVI, The Nature of Manures—continued; Chapter XVII, Stimulating Manures—Lime, Plaster, Ashes, and Marl; Chapter XVIII, Improvement of the Soil; Chapter XIX, Succession of Crops; Chapter XX, Grasses; Chapter XXI, Grasses—continued; Chapter XXII, Hemp; Chapter XXIII, Hops; Chapter XXIV, Ruta-baga; Chapter XXV, Pasture; Chapter XXVI, The Culture of Silk; Chapter XXVII, History of Silk; Chapter XXVIII, Silk—continued; Chapter XXIX, Sugar Made from Beets; Chapter XXX, Beet Sugar—continued; Chapter XXXI, Best Breeds of Cattle; Chapter XXXII, The Different Breeds of Neat Cattle Compared; Chapter XXXIII, On Buying and Stocking a Farm with Cattle; Chapter XXXIV, The Cow—Raising Calves; Chapter XXXV, Working Oxen; Chapter XXXVI, Pasturing Cattle; Chapter XXXVII, Soiling Cattle; Chapter XXXVIII, Stall-Feeding Beef Cattle; Chapter XXXIX, Milch Kine; Chapter XL, The Pasture and Other Food Best for Cows, as Regards Their Milk; Chapter XLI, The Management of Milk and Cream—Making and Preserving Butter; Chapter XLII, Making and Preserving Cheese; Chapter XLIII, Swine; Chapter XLIV, Diseases of Cattle; Chapter XLV, Diseases Peculiar to Oxen, Cows, and Calves; Chapter XLVI, Diseases of Horses; Chapter XLVII, Sheep; Chapter XLVIII, Sheep—continued; Chapter XLIX, The Farmyard; Chapter L, The Farmyard—continued.

1839. JOHN ARMSTRONG. *A Treatise on Agriculture: Comprising a Concise History of its Origin and Progress; the Present Condition of the Art Abroad and at Home, and the Theory and Practice of Husbandry. To which is added a Dissertation on the Kitchen and Fruit Garden. With Notes by J. Buel.* Harper & Bros. Pp. 282. No. 88 of "School District Library."

Chapter I, of the Rise and Progress of Agriculture; Chapter II, of the Actual State of Agriculture in Europe; Chapter III, Theory of Vegetation; Chapter IV, of the Analysis of Soils and of the Agricultural Relations Between Soils and Plants; Chapter V, of Practical Agriculture and its Necessary Implements; Chapter VI, of Manures, Their Management and Application; Chapter VII, of Tillage and the Principles on which it is Founded; Chapter VIII, of a Rotation of Crops and the Principles on which it is Founded; Chapter IX, of the Plants Recommended for a Course of Crops in the Preceding Chapter and Their Culture; Chapter X, of Other Plants Useful in a Rotation of Crops and Adapted to Our Climate; Chapter XI, of Meadows; Chapter XII, of Farm Cattle; Chapter XIII, of the Dairy; Chapter XIV, of Orchards; Chapter XV, of the Kitchen Garden; Chapter XVI, of the Fruit Garden.

1842. ALONZO GRAY, A. M., Teacher of Chemistry and Natural History in Philips Academy, Andover, Mass. *Elements of Scientific and Practical Agriculture, or the Application of Biology, Geology, and Chemistry to Agriculture and Horticulture. Intended as a Text-Book for Farmers and Students in Agriculture.* Van Nostrand & Terrett, New York. Copyright 1842. Pp. 368.

Introduction. Part First is "Biology of Plants:" Chapter I, The Vital Principle; Chapter II, Influence of the Atmosphere, Water, and Other Agents upon the Vital Principle, as Connected with the Phenomena of Vegetation; Chapter III, Productions of the Vital Principle—Their Character, Composition, Sources, and Assimilation. Part Second is "Geology and Chemistry of Soils:" Chapter IV, Rocks and Their Relation to Vegetation; Chapter V, Soils and Their Relation

to Vegetation; Chapter VI, Improvement of the Soil; Chapter VII, Improvement of the Soil by Manures and Tillage; Chapter VIII, Practical Agriculture; Chapter IX, Horticulture.

1848. N. S. DAVIS, M. D. *A Text-Book on Agriculture.* Samuel S. & William Wood, New York. Pp. 187. Illustrated with pictures of chemical apparatus and of insects.

Chapter I, Agricultural Science: (1) Agents Productive of Chemical Changes in Matter (Caloric, Attraction, Light, Electricity), (2) Classification of Bodies, (3) Chemical Nomenclature, or System of Naming, (4) Laws of Chemical Combinations; Chapter II, Organic Elements, Inorganic Elements; Chapter III, (1) Formation of Soils, (2) Classification of Soils, (3) Composition of Soils; Chapter IV, (1) Composition of Vegetables, (2) Sources from which Living Vegetables Derive their Ingredients; Chapter V, The Means Possessed by Man for Fertilizing the Soil and Adapting it for the Growth of any Crop which He May Desire, the Addition of Inorganic Substances as Means of Fertilizing the Soil, Vegetable and Animal Substances as Fertilizers of the Soil; Chapter VI, (1) Inorganic Substances Used as Manure, (2) Organic or Vegetable and Animal Manures; Chapter VII, The Best Modes of Analyzing Vegetable Substances and Soils, with Tables Showing the Composition of the Various Grains, Grasses, Soils, etc., According to the Analysis of the Best Chemists; Chapter VIII, Practical Agriculture and Horticulture, (1) Germination of Seeds, (2) Influence of Caloric, Light, and Electricity, (3) Description of Particular Grains, Grasses, etc., (4) Rotation of Crops, (5) Connection of Farm Stock with Vegetation, (6) Selection, Preservation, and Preparation of Seeds, and the Propagation of Plants by Cuttings, Layers, Buds, Grafts, etc. Appendix on Insects Injurious to Vegetation.

1848. M. M. RODGERS, M. D. *Scientific Agriculture, or the Elements of Chemistry, Geology, Botany, and Meteorology, Applied to Practical Agriculture.* Illustrated by Numerous Engravings and a Copious Glossary. Erastus Darrow, Rochester. Pp. 279.

Part I, Chemistry: Chapter I, Introductory; Chapter II, Light; Chapter III, General Properties of Gases; Chapter IV, Elementary Bodies; Chapter V, Fermentation. Part II, Geology: Chapter I, Introductory; Chapter II, Granite. Part III, Botany. Chapter I, Introductory; Chapter II, Organs and Structure of the Flower; Chapter III, Structure and Functions of the Leaf; Chapter IV, General Remarks. Part IV, Meteorology: Chapter I, Introductory; Chapter II, Rain; Chapter III, Various Aërial Phenomena. Part V, Agriculture: Chapter I, Formation and Elements of Soils; Chapter II, Metals, Metalloids, and Organic Elements of Soils; Chapter III, Physical Properties of Soils; Chapter IV, Tillage; Chapter V, Stereology—Manures; Chapter VI, Mineral Manures; Chapter VII, Tables of Analyses; Chapter VIII, Analysis of Soils; Chapter IX, Mechanical Philosophy. Glossary.

A second edition was published in 1850, of 296 pages, by Erastus Darrow, Rochester; C. M. Saxton, New York; J. P. Jewett & Co., Boston. It is said that over 3,000 copies of this second edition were sold; and the plates were still in existence in 1899.

1848. L. BENTZ, Director of the Normal Primary School of the Meurthe, France, and A. J. CHRÉTIEN, of Roville, Professor of Rural Economy in the same school. *Elements of Agriculture, for the Use of Primary and Secondary Schools.* Translated and adapted

to the use of rural primary schools of the United States of America by F. G. Skinner. C. M. Saxton & Co., New York. Copyright 1848. Pp. 91.

Part I: Chapter I, General Notions on the Art of Cultivating the Soil and of the Different Objects that Exist in Nature; Chapter II, Vegetable Anatomy and Physiology; Chapter III, the Reproduction of Vegetables. Part II: Chapter I, General Consideration of the Soil; Chapter II, the Physical Properties of Soil. Part III: Chapter I, Ameliorators; Chapter II, Stimulants; Chapter III, Manures.

1850. JOHN P. NORTON, M. A., Professor of Scientific Agriculture in Yale College. Elements of Scientific Agriculture, or the Connection Between Science and the Art of Practical Farming. Prize Essay of the New York State Agricultural Society. Adapted to the use of Schools. A. O. Moore, New York. Copyright 1850. Pp. 208.

Introduction; Organic Elements of Plants; Inorganic Part of Plants, or Ash; Sources of the Organic Food of Plants; the Organic Substances of Plants; the Soil; Manures; Composition of Different Crops; Application of the Crops in Feeding; Milk and Dairy Produce generally; Recapitulation; Nature of Chemical Analysis; Applications of Geology to Agriculture.

Norton's book went to a second edition in 1851 and to a fifth in 1854.

1851. REV. JOHN L. BLAKE, D. D. Lessons in Modern Farming, or Agriculture for Schools. Containing Scientific Exercises for Recitation and Elegant Extracts from Rural Literature for Academic or Family Reading. Mark H. Newman & Co., New York. Pp. 432. The cover stamp is "Agriculture for Schools."

Has no table of contents. The first essays are Moral Dignity of American Labor, The Harbinger of Spring, the Old Grist-mill (poem), Thanksgiving Day (poem), Scientific Terms in Agriculture, Agricultural Chemistry, The Crop of Acorns (poem), The American Ploughman, Physiological Reflections on Water, The Superiority of Educated Labor.

1854. GEORGE E. WARING, JR., Consulting Agriculturist. The Elements of Agriculture: A Book for Young Farmers. With Questions Prepared for the Use of Schools. Clark & Maynard, New York. Copyright 1854. Pp. 288.

Section I, The Plant: Chapter I, Introduction; Chapter II, Atmosphere; Chapter III, Hydrogen, Oxygen, and Nitrogen; Chapter IV, Inorganic Matter; Chapter V, Growth; Chapter VI, Proximate Division of Plants; Chapter VII, Location of the Proximates and Variations in the Ashes of Plants; Chapter VIII, Recapitulation. Section II, The Soil: Chapter I, Formation and Character of the Soil; Chapter II, Uses of Organic Matter; Chapter III, Uses of Inorganic Matter. Section III, Manures: Chapter I, Character and Varieties of Manure; Chapter II, Excrements of Animals; Chapter III, Waste of Manure; Chapter IV, Absorbents; Chapter V, Composting Stable Manure; Chapter VI, Different Kinds of Animal Excrement; Chapter VII, Other Organic Manures; Chapter VIII, Mineral Manures; Chapter IX, Deficiencies of Soils, Means of Restoration, etc.; Chapter X, Atmospheric Fertilizers; Chapter XI, Recapitulation. Section IV, Mechanical Cultivation: Chapter I, Mechanical Character of the Soil; Chapter II, Underdraining; Chapter III, Advantage of Underdraining; Chapter IV, Subsoil Plowing; Chapter V, Plowing and Other Modes of Pulverizing the Soil; Chapter VI,

Rolling, Mulching, Weeding, etc. Section V, Analysis: Chapter I, Nature of Analysis; Chapter II, Tables of Analysis. *The Practical Farmer. Explanation of Terms.*

For second edition, see entry under 1868.

1854. CHARLES FOX, Lecturer on Agriculture in the University of Michigan. *The American Text-Book of Practical and Scientific Agriculture, Intended for the Use of Colleges, Schools, and Private Students, as well as for the Practical Farmer. Including Analyses by the Most Eminent Chemists.* Elwood & Co., Detroit. Pp. 354.

Chapter I, Introductory; Chapter II, Plants, the Air, Water; Chapter III, The Soil; Chapter IV, Meteorology; Chapter V, Formation of Plants; Chapter VI, Wheat; Chapter VII, Rye; Chapter VIII, Barley; Chapter IX, Oats; Chapter X, Indian Corn; Chapter XI, Rice, Buckwheat, Millet, Canary Grass; Chapter XII, Leguminous Plants—Beans, Peas, Lentils, Vetches, and Lupines; Chapter XIII, Grasses and other Fodder Plants; Chapter XIV, Clover and other Forage Plants; Chapter XV, Plants Cultivated for their Roots and Leaves—Turnips, Kohl Rabi, Cabbage, Rape; Chapter XVI, Potato, Jerusalem Artichoke; Chapter XVII, Parsnip, Carrot, Beet; Chapter XVIII, Sweet Potatoes, Mustard, Hops; Chapter XIX, Onions, Pumpkins, Tobacco, Castor-Oil Bean, Licorice, Uncommon Plants; Chapter XX, Teasel, Flax, Hemp, Broom Corn, Ozier Willow; Chapter XXI, Fruit Trees and Vegetables; Chapter XXII, Manures; Chapter XXIII, Plowing.

1857. J. A. NASH, Principal of Mount Pleasant Institute, Instructor of Agriculture in Amherst College, and Member of the Massachusetts Board of Agriculture. *The Progressive Farmer: A Scientific Treatise on Agricultural Chemistry and the Geology of Agriculture. On Plants, Animals, Manures, and Soils. Applied to Practical Agriculture.* A. O. Moore, New York. Pp. 254.

Chapter I, Agricultural Chemistry; Chapter II, Geology of Agriculture; Chapter III, Vegetable Physiology; Chapter IV, Animals and their Products; Chapter V, Manures; Chapter VI, Practical Agriculture.

1859. J. L. CAMPBELL, A. M., Professor of Physical Science, Washington College, Va. *A Manual of Scientific and Practical Agriculture for the School and the Farm, with Numerous Illustrations.* Lindsay & Blakiston, Philadelphia. Pp. 442.

Chapter I, Preliminary Definitions and Illustrations; Chapter II, Heat, Light, Electricity; Chapter III, Chemical Symbols, Equivalents, and Nomenclature; Chapter IV, History and Properties of the Metalloids; Chapter V, History and Properties of the Metals; Chapter VI, Organic Chemistry—Chemistry of Plants; Chapter VII, Mineral Constituents, or Ashes, of Plants; Chapter VIII, Animal Chemistry; Chapter IX, Sources from which Plants Derive Their Nourishment; Chapter X, General Principles of Vegetable Physiology; Chapter XI, Structure and Functions of the Organs of Plants; Chapter XII, The Soil—Its Geological Origin, etc.; Chapter XIII, Mechanical Management of the Soil; Chapter XIV, Chemical Treatment of the Soil; Chapter XV, History and Properties of Special Manures; Chapter XVI, Application of Fertilizers—Planting and Culture of Crops; Chapter XVII, Culture of Indian Corn; Chapter XVIII, Culture of Wheat and Oats; Chapter XIX, Planting and Culture of Potatoes; Chapter XX, Hay Crops and Pasture; Chapter XXI, Beans and Peas—Especially the "Southern Pea:"

Chapter XXII, Culture and Management of Tobacco; Chapter XXIII, The Cotton Crop; Chapter XXIV, Rotation of Crops; Chapter XXV, Value of Crops as Food; Chapter XXVI, Animal Physiology; Chapter XXVII, Selection and Preparation of Food; Chapter XXVIII, Selection and Care of Stock.

1861. JAMES F. W. JOHNSTON, M. A., etc. *Catechism of Agricultural Chemistry and Geology*. Approved by the Provincial Board of Education for Use in the Schools in New Brunswick. Fortieth Edition. Barnes & Co., St. John, N. B. Pp. 68.

An English work reprinted. Contains 406 questions with answers.

1862. GEORGE B. EMERSON and CHARLES L. FLINT, the latter Secretary of the Massachusetts State Board of Agriculture. *Manual of Agriculture, for the School, the Farm, and the Fireside*. Swan, Brewer & Tileston, Boston. Pp. 306.

Chapter I, Introduction; Chapter II, The Air and the Gases in It; Chapter III, The Atmosphere and the Forces Acting in It; Chapter IV, Changes in the Atmosphere—Instruments to Measure them—Climate; Chapter V, Of Water; Chapter VI, Of Plants; Chapter VII, Elements of Plants; Chapter VIII, Organic Compounds in Plants; Chapter IX, The Soil; Chapter X, Of the Subsoil; Chapter XI, Of Amendments; Chapter XII, Of Fertilizers; Chapter XIII, Of Tillage; Chapter XIV, Preparation of Lands; Chapter XV, Sowing, Planting, etc.; Chapter XVI, Culture of the Cereals; Chapter XVII, Leguminous Plants; Chapter XVIII, Esculent Roots; Chapter XIX, the Grasses—Formation of Meadows or Upland Mowings; Chapter XX, Plants used in the Arts and Manufactures; Chapter XXI, Of Rotation of Crops; Chapter XXII, The Harvest; Chapter XXIII, Diseases and Enemies of Growing Plants; Chapter XXIV, Management of Farm Stock; Chapter XXV, The Economy of the Farm; Chapter XXVI, Economy of the Household. Questions.

For second edition see entry under 1885.

1864. J. W. DAWSON, Principal of McGill University. *First Lessons in Scientific Agriculture*. For Schools and Private Instruction. John Lovell, Montreal, and Adam Miller, Toronto. Pp. VIII+208.

Chapter I, The Science of Agriculture and its Uses; Chapter II, How May Scientific Agriculture be Best Taught in Schools; Chapter III, Chemical Combination and Decomposition; Chapter IV, Simple Substances of which Plants Consist; Chapter V, Sources of the Organic Food of Plants; Chapter VI, Structure of Plants; Chapter VII, Organic Compounds Produced by Plants; Chapter VIII, The Ashes of Plants; Chapter IX, The Soil; Chapter X, Exhaustion of the Soil; Chapter XI, Improvement of the Soil; Chapter XII, Manures; Chapter XIII, Crops; Chapter XIV, Suggestions as to Practical Applications. Appendix, comprising Application of Meteorology to Agriculture; Directions for Performing Experiments; Rotation of Crops for Canada.

1868. GEORGE E. WARING, Jr. *The Elements of Agriculture: A Book for Young Farmers*. Second and revised edition. Orange Judd Co., New York. Copyright 1868. Pp. 254.

Section I, The Plant: Chapter I, Introduction; Chapter II, The Atmosphere and its Carbon; Chapter III, Hydrogen, Oxygen, and Nitrogen; Chapter IV, Earthy

Matter; Chapter V, Growth; Chapter VI, Starch, Woody Fiber, Gluten, etc.; Chapter VII, Location of the Different Parts and Variations in the Ashes of Plants; Chapter VIII, Recapitulation. Section II, The Soil: Chapter I, Formation and Character of the Soil; Chapter II, Uses of Atmospheric Matter; Chapter III, Uses of Earthy Matter. Section III, Manures: Chapter I, Character and Varieties of Manures; Chapter II, Animal Excrement; Chapter III, Waste of Manure; Chapter IV, Absorbents; Chapter V, Composting Stable Manure; Chapter VI, Different Kinds of Animal Excrement; Chapter VII, Other Organic Manures; Chapter VIII, Mineral Manures; Chapter IX, Deficiencies of Soils, Means of Restoration, etc.; Chapter X, Atmospheric Fertilizers; Chapter XI, Recapitulation. Section IV, Mechanical Cultivation: Chapter I, The Mechanical Character of Soils; Chapter II, Underdraining; Chapter III, Advantages of Underdraining; Chapter IV, Subsoil Plowing; Chapter V, Plowing and Other Processes of Pulverizing the Soil; Chapter VI, Rolling, Mulching, Weeding, etc. Section V, Analysis: Chapter I, Analysis; Chapter II, Tables of Analysis. The Practical Farmer. Explanation of Terms.

1870. EGERTON RYERSON. *First Lessons on Agriculture; for Canadian Farmers and Their Families.* Copp, Clark & Co., Toronto. Copyright 1870. Pp. XI+216.

Part I, Preparatory Knowledge: Chapter I, The Farmer and His Profession; Chapter II, On the Two Kinds of Substances with which the Farmer has to do—Organic and Inorganic; Chapter III, On the Organic Constituents of Plants and Animals; Chapter IV, The Fifteen Elementary Substances; Chapter V, Explanation of Chemical Terms; Chapter VI, Definitions of the Acids, Bases, and Salts; Chapter VII, Oxygen, Hydrogen, Nitrogen, Carbon; (no Chapter VIII); Chapter IX, Chlorine, Sulphur, Phosphorus; Chapter X, Metals—Potassium and Sodium; Chapter XI, Calcium and Magnesium; Chapter XII, Aluminum and Silicon; Chapter XIII, Metals Employed in the Arts—Iron and Manganese; Chapter XIV, Other Useful Metals—Tin, Copper, Zinc, Lead; Chapter XV, The Noble Metals—Mercury, Silver, Platinum, Gold; Chapter XVI, Kinds of Soils; Chapter XVII, Structure of Plants and Offices of Their Organs. Part II, Preparatory Knowledge Applied: Chapter XVIII, Composition of Soils and Plants and Their Relations to Each Other; Chapter XIX, Soils Adapted to Different Kinds of Grain and Vegetables; Chapter XX, How to Conserve Soils; Chapter XXI, Vegetable Manures; Chapter XXII, Animal Manures; Chapter XXIII, Mixed Manures; Chapter XXIV, Inorganic or Mineral Manures—Lime; Chapter XXV, Inorganic or Mineral Manures—Marls, Gypsum; Chapter XXVI, Ashes; Chapter XXVII, Other Inorganic or Mineral Manures; Chapter XXVIII, Amendments, Irrigation, Drainage, Subsoil Plowing; (no Chapter XXIX); Chapter XXX, Rotation of Crops; Chapter XXXI, Sowing, Care, and Harvesting of Grain Crops; Chapter XXXII, Leguminous Crops; Chapter XXXIII, Roots or Esculent Plants; Chapter XXXIV, Grasses, Meadows, Pastures; Chapter XXXV, Fruits; Chapter XXXVI, Plants Used in Arts and Manufactures; Chapter XXXVII, Economy of the Farm; Chapter XXXVIII, Economy of the Household; Chapter XXXIX, Miscellaneous Questions and Answers Relating to Natural History. Index and Explanation of Terms.

A second edition of Ryerson appeared in 1871 as one of the "Canadian Series of School Books." There is no change except in the numbering of the chapters.

There was another early Canadian work by Prof. Henry Yonle Hind. Its title has been quoted to me as "Lectures on Agricultural Chemistry, or Elements of the Science of Agriculture," and is said to have been published in 1850.

1875. E. M. PENDLETON, M. D., Professor of Agriculture and Horticulture in the University of Georgia. *Text-Book of Scientific Agriculture, with Practical Deductions.* Intended for the Use of Colleges, Schools, and Private Students. A. S. Barnes & Co., New York. Copyright 1874. Pp. 419.

Part I, Anatomy and Physiology of Plants, comprising nine chapters. Part II, Agricultural Meteorology, comprising four chapters. Part III, Soils as Related to Physics, comprising seven chapters. Part IV, Chemistry of the Atmosphere, comprising four chapters. Part V, Chemistry of Plants, comprising ten chapters. Part VI, Chemistry of Soils, with nine chapters. Part VII, Fertilizers and Natural Manures, eight chapters. Part VIII, Animal Nutrition, three chapters. Appendix with remarks on specific crops.

Second edition, 1877, pp. 443, being enlarged by an addendum "embracing recent discoveries in agricultural science."

1878. THOMAS P. JAMES, Commissioner of Agriculture of the State of Georgia. *The Farmer's Scientific Manual.* Department of Agriculture, Atlanta, Ga. Pp. 168.

Chapter I, General Chemistry; Chapter II, Plants—The Structure and Offices of Their Different Parts; Chapter III, Chemical Composition of Plants; Chapter IV, Plant Fertilization; Chapter V, Soil Fertilization; Chapter VI, Soils in Their Relation to Vegetation; Chapter VII, Fertilizers; Chapter VIII, Plants and Their Products as Food for Animals; Chapter IX, Agricultural Experiments; Chapter X, Farm Drainage; Chapter XI, Irrigation; Chapter XII, Meteorology in its Relations to Agriculture; Chapter XIII, Entomology in its Relations to Agriculture. Appendix.

1880. N. T. LUPTON, LL. D., Professor of Chemistry in Vanderbilt University, Nashville, Tenn. *The Elementary Principles of Scientific Agriculture.* American Book Company. Pp. 107.

Chapter I, The Development of Scientific Agriculture; Chapter II, The Origin, Composition, and Classification of Soils; Chapter III, The Composition of Plants; Chapter IV, Composition and Properties of the Atmosphere; Chapter V, The Sources of Plant Food and How Obtained; Chapter VI, The Improvement of Soils; Chapter VII, The Use of Manures and Fertilizers; Chapter VIII, Mineral Fertilizers; Chapter IX, Rotation of Crops; Chapter X, The Selection and Care of Live Stock. Appendix. Questions.

1882. HENRY TANNER. *First Principles of Agriculture.* Canada Publishing Co., Toronto. Pp. 95. (Canadian edition of a British book, with Canadian preface by Prof. William Brown. The first London edition was 1878; the second 1879.)

Chapter I, The Soil; Chapter II, Composition of Crops; Chapter III, Fertility of the Soil; Chapter IV, Farm Manures; Chapter V, Artificial Manures; Chapter VI, Natural Manures; Chapter VII, Tillage Operations; Chapter VIII, Rotation of Crops; Chapter IX, Live Stock; Chapter X, Food of Farm Stock. Appendix.

1882. R. S. THOMPSON. *Science in Farming. A Text-Book on the Principles of Agriculture, Including a Treatise on Agricultural*

Chemistry. Designed for use in schools, granges, farmers' clubs, and by farmers and their families. Published by the Farmers' Advance, Springfield, O. Pp. 186.

Chapter I, Science in Farming; Chapter II, Science in its Elements; Chapter III, Science in Heat and Energy; Chapter IV, Chemistry; Chapter V, Science in Air; Chapter VI, Science in Soils; Chapter VII, Science in Plant Growth; Chapter VIII, Science in Animal Life; Chapter IX, Science in Foods; Chapter X, Science in Feeding; Chapter XI, Science in Fertilizers.

1883. ALLEN BOWIE DAVIS, late President of the Board of Trustees of the Maryland Agricultural College. *Elementary Agriculture*. For the use of schools. John B. Piet & Co., Baltimore. Pp. VI+126.

Chapters I-VI, Definitions; Chapter VII, The Object of Plowing; Chapters VIII-XIII, Corn; Chapters XIV-XVI, Wheat; Chapter XVII, Rotation of Crops, Tobacco; Chapter XVIII, Tobacco—continued; Chapter XIX, Rye, Ergot; Chapter XX, Oats; Chapter XXI, Potatoes; Chapter XXII, Cabbage; Chapter XXIII, The Carrot—A Useful Food for Consumptives; Chapter XXIV, The Parsnip—"It is Nerve and Brain Food;" Chapter XXV, The Onion—How Used in Ancient Times; Chapter XXVI, The Turnip—Its Medicinal Properties; Chapter XXVII, The Bean—Wholesome Food for Man and Beast; Chapter XXVIII, The Pea—Good for Scorbutic Humors; Chapter XXIX, Lettuce—A Promoter of Sleep; Chapter XXX, The Beet—Sometimes Used to Make Sugar; Chapter XXXI, The Eggplant—How Raised and Cooked; Chapter XXXII, The Tomato—Antibilious, and a Preventive of Chills and Fevers; Chapter XXXIII, The Strawberry—The Best Way to Cultivate; Chapter XXXIV, Berries—Their Healthfulness and Pecuniary Value; Chapter XXXV, The Grape—Beneficial for the General Health; Chapter XXXVI, The Horse-radish and Common Radish—Excellent for Digestion; Chapter XXXVII, Parsley, Celery, and Rhubarb; Chapter XXXVIII, Asparagus and Poke; Chapter XXXIX, The Barometer—Signs of Rain; Chapter XL, Review; Chapter XLI, The Horse, Cow, and Hog; Chapter XLII, Agricultural Machinery—Its Uses; Chapter XLIII, The Farmhouse; Chapter XLIV, Flower Gardens; Chapter XLV, Sentiments of Plants and Flowers; Chapter XLVI, The Geranium; Chapter XLVII, Botanical Geography; Chapter XLVIII, Cereals; Chapter XLIX, Zones, Tropics, and Breed Lines; Chapter L, Raising Poultry; Chapter LI, Sheep Raising; Chapter LII, Fruit Trees; Chapter LIV, Canning; Chapter LV, Butter; Chapter LVI, The Weather—The Moon; Chapter LVII, Tea and Coffee; Chapter LVIII, Thunderstorms; Chapter LIX, Clover; Chapter LX, Remarks on Grasses. Appendices I and II.

1885. EMERSON and FLINT. *Manual of Agriculture*. A new edition, revised by Dr. Charles A. Goessmann, Professor of Chemistry, Massachusetts Agricultural College. Orange Judd Co., New York. Copyright 1885. Pp. 284.

Has the same chapters as the first edition (1862), but the questions are omitted from the end of the volume.

1887. F. A. GULLEY, Professor of Agriculture in Agricultural College of Mississippi, Starkville, Miss. *First Lessons in Agriculture*. Published by the Author. Pp. 118.

Chapter I, Composition of Matter; Chapter II, Origin and Formation of Soils;

Chapter III, Composition of the Soil; Chapter IV, Composition of the Plant; Chapter V, Plant Food in the Soil; Chapter VI, Mechanical Condition of the Soil; Chapter VII, Effect of Water on the Soil and Crop; Chapter VIII, Farm Drainage; Chapter IX, Preparation of the Land for the Crop; Chapter X, How Plants Grow; Chapter XI, Fertilization of the Seed; Chapter XII, Improvement of Variety; Chapter XIII, Cultivation of the Crop; Chapter XIV, Manures; Chapter XV, Commercial Fertilizers; Chapter XVI, Care of Manure—Composting; Chapter XVII, Rotation of Crops; Chapter XVIII, Farm Live Stock; Chapter XIX, Diversified Farming; Chapter XX, Food and Manure Value of Crops. Glossary.

A second edition, revised and enlarged, appeared in 1892, by the Rural Publishing Company, New York. Pp. 155. Illustrated. The following chapters are added: Farm Live Stock; Breeds of Horses; Breeds of Cattle; Sheep.

1888. The "A B C of Agriculture," by MASON C. WELD and other writers. Published by the Orange Judd Co., New York. Copyright 1887. Pp. 66.

Advertised as a book "adapted to district and rural schools," but there is no evidence in the book that it was written as a definite text-book.

1890. JAMES MILLS, M. A., President Ontario Agricultural College, and THOMAS SHAW, Professor of Agriculture, Ontario Agricultural College. The First Principles of Agriculture. Authorized by the honorable the minister of education for use in the public schools of Ontario. J. E. Bryant Co., Toronto. Pp. 250.

Chapter I, Definitions and Explanations; Chapter II, The Plant; Chapter III, The Soil; Chapter IV, Tillage—Introductory; Chapter V, Tillage—The Improvement of Soils; Chapter VI, Tillage—The Preparation of the Soil for the Seed; Chapter VII, Tillage—The Rotation of Crops; Chapter VIII, The Crops of the Farm—Their Growth and Management; Chapter IX, Crops for Soiling; Chapter X, The Weeds of the Farm; Chapter XI, Diseases of Crops; Chapter XII, Insects; Chapter XIII, Outlines of the Principles of Feeding; Chapter XIV, The Feeding, Care, and Management of Horses, Cattle, Sheep, and Swine; Chapter XV, Breeding; Chapter XVI, The Breeds of Live Stock; Chapter XVII, Dairying; Chapter XVIII, The Silo and Ensilage; Chapter XIX, The Cultivation of Forest Trees for Shade, Ornament, and Protection.

1891. I. O. WINSLOW, A. M. The Principles of Agriculture for Common Schools. American Book Co. Pp. 152.

Suggestions to Teachers; Chapter I, The Substances of the Earth; Chapter II, Land and Water; Chapter III, The Atmosphere; Chapter IV, Plants; Chapter V, Fertilizers; Chapter VI, Cultivation; Chapter VII, Animals. Glossary.

1895. R. HEDGER WALLACE, late Lecturer and Examiner in Agriculture to the Education Department of Victoria and the Victorian Department of Agriculture. Agriculture. Illustrated. J. B. Lipincott Co. Pp. 352.

"This book has been written with the object of placing before the student and reader a simple statement of the principles of agriculture," etc. Chapter I, Introduction; Chapter II, The Natural Kingdoms; Chapter III, Forms of Matter; Chapter IV, Atmospheric Air; Chapter V, Atmospheric Air—continued; Chapter VI,

Water; Chapter VII, Metals; Chapter VIII, Nonmetals; Chapter IX, Oxides and Salts, Acids and Alkalies; Chapter X, Carbon Compounds; Chapter XI, The Ash and Volatile Portion of Plants; Chapter XII, Soil Food of Plants; Chapter XIII, Seed—Germination; Chapter XIV, Growth—Office of Leaves; Chapter XV, Growth—Sap Movements; Chapter XVI, Blossoms and Their Functions; Chapter XVII, Farm Seeds; Chapter XVIII, What Are Soils?; Chapter XIX, Lava and Peat Soils; Chapter XX, Humus and Stones; Chapter XXI, Properties of Soils; Chapter XXII, Conditions of Fertility; Chapter XXIII, Classification of Soils; Chapter XXIV, Some Constituents of Soils; Chapter XXV, Soil Physics; Chapter XXVI, What Frost, Water, and Air Do to Rocks; Chapter XXVII, Removed Soils; Chapter XXVIII, Formation of Surface Soil and Subsoil; Chapter XXIX, Soil Chemistry; Chapter XXX, Soil Chemistry—continued; Chapter XXXI, Cultivation—A Means of Enriching Land; Chapter XXXII, Cultivation—A Means of Cleaning the Land; Chapter XXXIII, Cultivation—A Preparation for Seed; Chapter XXXIV, Cultivation—An Aid to Root Development; Chapter XXXV, Tillage; Chapter XXXVI, Implements for Working Soils—Plows; Chapter XXXVII, Implements for Working Soils—Cultivators, Harrows, etc.; Chapter XXXVIII, Implements for Sowing Seed; Chapter XXXIX, Implements for Interculture; Chapter XL, Exhaustion and Improvement of Soils; Chapter XLI, Claying and Sanding, Paring and Burning, Marling, Warping, etc.; Chapter XLII, Drainage; Chapter XLIII, Drainage Systems and Methods; Chapter XLIV, Irrigation; Chapter XLV, Manure; Chapter XLVI, The Character and Preparation of Farmyard Manure; Chapter XLVII, Composition and Effect of Farmyard Manure; Chapter XLVIII, Food in Relation to Manure; Chapter XLIX, Other General Manures; Chapter L, Phosphatic Manures; Chapter LI, Nitrogenous Manures; Chapter LII, Potash and Other Manures; Chapter LIII, Lime; Chapter LIV, Rotation of Crops; Chapter LV, Rotation for a Light Soil; Chapter LVI, Rotation for a Clay Soil; Chapter LVII, Rotation for Loams; Chapter LVIII, Distinctive Characteristics of Crops; Chapter LIX, Wheat and Rye; Chapter LX, Barley; Chapter LXI, Oats; Chapter LXII, Meadow Grass and Meadow Hay; Chapter LXIII, Grass Seeds; Chapter LXIV, Beans and Peas; Chapter LXV, Leguminous Fodder Crops—Vetches, Clovers, Sainfoin, Lucerne; Chapter LXVI, Other Fodder Crops; Chapter LXVII, Root Crops—Mangel-Wurzel, Turnip; Chapter LXVIII, Root Crops—Swede, Potato; Chapter LXIX, Harvesting and Other Machinery; Chapter LXX, Conclusion.

1895. Our Canadian Prairies. Being a Description of the Most Notable Plants of Manitoba; the Chief Noxious Weeds and How to Destroy Them; the Trees and Wild Fruits, along with Arbor-Day Exercises and Poems. C. Blackett Robinson,[[]Toronto. Copyright 1895. Pp. 162. Manitoba Course of Agriculture, first series.

Plant life in Manitoba; flowers and gardens; the flower of the heart (poem); how to collect and preserve plants; how to tell the flowers; thirty notable plants; the Carmen Hill convention; Shakespeare praises country life; Arbor Day—its importance to Manitoba. Appendix: Key for determining plants; explanation of terms; four model schedules; list of thirty notable plants—their common and botanical names and times of flowering; list of eleven noxious weeds of Manitoba; list of fourteen wild fruits of Manitoba; list of sixteen forest trees of Manitoba.

- 1895 (?). Prairie Agriculture. Containing a List of Chemical Experiments; A Series of Experiments on the Growth of Seeds; A Description of How Plants Grow; A Sketch of the Formation of

the Prairie Soil by Water and Ice Action; An Account of Farming Operations and of Crops Adapted to Manitoba; A Description of Diseases of Crops, of Insects, and of Birds; An Account with Illustrations of the Breeds of Horses, Cattle, Sheep, Swine, and Poultry Adapted to Manitoba; Advantages of Mixed Farming. The Consolidated Stationery Co., Winnipeg. Pp. 259. Manitoba Course of Agriculture, second series.

The work of the farmer; chemical experiments bearing on agriculture; experiments on plant growth; how plants grow; formation of soil; drainage; road making; well boring; composition of soil; improvement of soil; selection of a farm; breaking the prairie; plowing; harrowing; cultivating; farrowing; sowing; rolling; rotation of crops; wheat; oats; barley; peas; flax; turnips; mangles; carrots; potatoes; fodder plants; grasses; weeds; diseases of crops; insects; birds; animal industry; breeding; feeding of farm stock; foods; management of stock; horses; cattle; sheep; swine; poultry; bees; mixed farming; farm buildings; fences; trees and shrubs.

Forty colored plates of the plants of Manitoba accompany these two books.

1896. EDWARD B. VOORHEES, A. M., Director of the New Jersey Agricultural Experiment Stations and Professor of Agriculture in Rutgers College. *First Principles of Agriculture*. Silver, Burdett & Co., Boston. Pp. 212.

Chapter I, The Constituents of Plants; Chapter II, Origin and Formation of Soils; Chapter III, Composition of Soils; Chapter IV, The Improvement of Soils; Chapter V, Natural Manures; Chapter VI, Artificial and Concentrated Manures—Nitrogenous Materials; Chapter VII, Artificial and Concentrated Manures—Phosphates; Chapter VIII, Artificial and Concentrated Manures—Superphosphates and Potash Salts; Chapter IX, Artificial Manures or Fertilizers—Methods of Buying, Valuation, Formulas; Chapter X, The Rotation of Crops; Chapter XI, The Selection of Seed, Farm Crops and Their Classification, Cereals, Grasses, Pastures, Roots, Tubers, and Market-Garden Crops; Chapter XII, The Growth of Animals, the Constituents of Animals and Animal Food, the Character and Composition of Fodders and Feeds; Chapter XIII, The Digestibility of Fodders and Feeds, Feeding Standards, Nutritive Ratio, the Exchange of Farm Products for Concentrated Feeds; Chapter XIV, Principles of Feeding, the Pure Breeds of Farm Stock; Chapter XV, The Products of the Dairy, Their Character and Composition, Dairy Management. Tables.

1897. SIR WILLIAM DAWSON, late Principal of McGill University. *First Lessons in the Scientific Principles of Agriculture*. For schools and private instruction. New edition, revised and enlarged, with the permission of the author, by S. P. Robins, Principal of the McGill Normal School. W. Drysdale & Co., Montreal. Copyright 1897. Pp. 323.

Introduction: The Science of Agriculture. Chapter I, Forms of Matter; Chapter II, Heat; Chapter III, Chemical Principles; Chapter IV, Chemical Processes; Chapter V, Chemical Properties of the Elements and Compounds Most Important in Agriculture; Chapter VI, Plants, Their Functions and Structures; Chapter VII, Organic Compounds Produced by Plants; Chapter VIII, The Ashes of Plants;

Chapter IX, The Atmospheric Food of Plants; Chapter X, The Soil, Origin, and Classification; Chapter XI, The Relation of the Soil to Plants; Chapter XII, Exhaustion of the Soil; Chapter XIII, Improvement of the Soil by Mechanical Means; Chapter XIV, Improvement of the Soil by Manures; Chapter XV, Crops; Chapter XVI, Soiling and Silos.

1898. CHARLES C. JAMES, Deputy Minister of Agriculture for Ontario, formerly Professor of Chemistry at the Ontario Agricultural College. Agriculture. George N. Morang, Toronto. Pp. 200.

Part I, The Plant: Chapter I, The Seed; Chapter II, The Young Plant; Chapter III, The Plant and Water; Chapter IV, The Plant and the Soil; Chapter V, The Plant and the Air; Chapter VI, Structure and Growth of the Plant; Chapter VII, Naming and Classification of Plants. Part II, The Soil: Chapter VIII, Nature and Origin of the Soil; Chapter IX, Tilling and Draining the Soil; Chapter X, Improving the Soil. Part III, The Crops of the Field: Chapter XI, The Grasses; Chapter XII, The Grain Crops or Cereals; Chapter XIII, The Leguminous Plants; Chapter XIV, Root Crops and Tubers; Chapter XV, Various Other Crops; Chapter XVI, Weeds; Chapter XVII, Insects of the Field; Chapter XVIII, The Diseases of Plants; Chapter XIX, Rotation of Crops. Part IV, The Garden, Orchard, and Vineyard: Chapter XX, The Garden; Chapter XXI, The Apple Orchard; Chapter XXII, Other Orchard Trees; Chapter XXIII, Insects of the Orchard; Chapter XXIV, Diseases of the Orchard; Chapter XXV, The Vineyard. Part V, Live Stock and Dairying: Chapter XXVI, Horses; Chapter XXVII, Cattle; Chapter XXVIII, Sheep; Chapter XXIX, Swine; Chapter XXX, Poultry; Chapter XXXI, Milk; Chapter XXXII, The Products of Milk; Chapter XXXIII, The Structure of Animals; Chapter XXXIV, Foods of Animals; Chapter XXXV, Digestion and Uses of Foods. Part VI, Other Subjects: Chapter XXXVI, Bees; Chapter XXXVII, Birds; Chapter XXXVIII, Forestry; Chapter XXXIX, Roads; Chapter XL, The Rural Home. Appendix: List of Trees; List of Weeds; Spraying Mixtures.

"American edition," 1899, edited by John Craig, Professor of Horticulture in the Iowa Agricultural College. Pp. 203. Preserves the original chapters and text, but uses various new cuts and inserts full-page half-tones, and adds three pages on adornment of school grounds.

1898. L. H. BAILEY, Professor of Horticulture in the Cornell University. The Principles of Agriculture: A text-book for schools and rural societies. The Macmillan Co., New York. Pp. 300.

Introduction: What Is Agriculture. Part I, The Soil: Chapter I, The Contents of the Soil; Chapter II, The Texture of the Soil; Chapter III, The Moisture in the Soil; Chapter IV, The Tillage of the Soil; Chapter V, Enriching the Soil—Farm Resources; Chapter VI, Enriching the Soil—Commercial Resources. Part II, The Plant and Crops: Chapter VII, The Offices of the Plant; Chapter VIII, How the Plant Lives; Chapter IX, The Propagation of Plants; Chapter X, Preparation of Land for the Seed; Chapter XI, Subsequent Care of the Plant; Chapter XII, Pastures, Meadows, and Forage. Part III, The Animal and Stock: Chapter XIII, The Offices of the Animal; Chapter XIV, How the Animal Lives; Chapter XV, The Feeding of the Animal; Chapter XVI, The Management of Stock. Glossary.

A second edition was published in January, 1900, a third in January, 1901, and other editions subsequently.

1900. ROMULO ESCOBAR, Editor of *El Agricultor Mexicano*. Tratado elemental de Agricultura, por el ingeniero agrónomo. C. Juarez, Chihuahua, Mexico. Pp. 207.

Prólogo del autor: Capítulo I, Generalidades; Capítulo II, Del Vegetal; Capítulo III, De la Atmósfera; Capítulo IV, Del Saco; Capítulo V, Del Agua; Capítulo VI, Reproducción de los Vegetales; Capítulo VII, Movilario Agrícola; Capítulo VIII, Prácticas Agrícolas.

1901. J. B. MCBRYDE, C. E., Virginia Polytechnic Institute. *Elements of Agriculture, for use in Schools*. B. F. Johnson Pub. Co., Richmond, Va. Copyright 1901. Pp. 270

Part I, Climate: Chapter I, Sunlight; Chapter II, Sunlight—continued; Chapter III, Rain; Chapter IV, The Atmosphere; Chapter V, The Atmosphere—continued. Part II, Plants: Chapter VI, Plants and Their Seed; Chapter VII, Parts of a Plant; Chapter VIII, Composition of Plants; Chapter IX, Composition of Plants—continued; Chapter X, The Food the Plant takes from the Soil; Chapter XI, The Food the Plant takes from the Air; Chapter XII, How Plants Grow. Part III, Soils: Chapter XIII, How Soils are Made; Chapter XIV, Classification of Soils; Chapter XV, Composition of Soils; Chapter XVI, Composition of Soils—continued; Chapter XVII, Water in Soils; Chapter XVIII, Nitrogen in the Soil; Chapter XIX, How Soils Lose Water; Chapter XX, How Soils Lose Nitrogen; Chapter XXI, How Soils Lose Mineral Matter; Chapter XXII, Cultivation of Soils; Chapter XXIII, Cultivation of Soils—continued. Part IV, Manures: Chapter XXIV, Classification of Manures; Chapter XXV, Commercial Fertilizers; Chapter XXVI, Commercial Fertilizers—continued; Chapter XXVII, Use of Manures. Part V, Farm Crops: Chapter XXVIII, Seed Testing; Chapter XXIX, Classification of Crops—Cereal and Fodder Crops; Chapter XXX, Fodder Crops and Pastures; Chapter XXXI, Root and Tuber Crops—Miscellaneous Crops; Chapter XXXII, Rotation of Crops. Part VI, Animal Production: Chapter XXXIII, Composition of Animals; Chapter XXXIV, Food, Work, and Growth of Animals; Chapter XXXV, Care of Animals; Chapter XXXVI, Feeding of Animals; Chapter XXXVII, Stock Food; Chapter XXXVIII, Digestibility of Stock Foods; Chapter XXXIX, Calculating Rations for Animals; Chapter XL, Selecting Stock Foods. Part VII, Miscellaneous Topics: Chapter XLI, Birds; Chapter XLII, Insectivorous Birds; Chapter XLIII, Seed-eating Birds; Chapter XLIV, Birds of Prey; Chapter XLV, Forestry; Chapter XLVI, Roads. Appendix (tables).

1901. WILLIAM P. BROOKS. *Agriculture. The Home Correspondence School, the King-Richardson Co., Proprietors, Springfield, Mass.*

Volume I. Soils and how to treat them (this being the title on the cover; the full legend on the title pages is "Soils, formation, physical and chemical characteristics and methods of improvement, including tillage and irrigation"). What agriculture is; essential definitions; classes of compounds; what the plant contains; the nature of the elements useful to plants and the sources from which plants derive them; summary; elements always found in plants but not known to be necessary; a soil element not found in plants; the soil; the formation of soils; mechanical agencies; the chemical action of air and water; plants and animals as soil formers and improvers; soils classified according to method of formation; the components of soils; agricultural classification of soils; light and heavy soils; leading characteristics of the different kinds of soil; physical characteristics of soils;

relation of the soil to water; relation of soil to heat; chemical characteristics of soils; the extent to which soils hold different food elements by chemical forces; improvement of soils; the mixture of soils; tillage; tillage implements and operations; ordinary plows and plowing; plowing; harrows and harrowing; rollers and rolling; cultivators and cultivating; hand implements; drainage; open drains; underdrains; points to be settled before the drains are put in; practical suggestions; obstructions in drains; irrigation; methods of obtaining water for irrigation; methods of application.

Volume II. Manures, fertilizers, and farm crops, including green manuring and crop rotation. Manures; farm manures; the excrements of our larger domestic animals; composition of litter; the application of farmyard manures; poultry manure; miscellaneous manurial substances; sea manures; fertilizers; fertilizers used chiefly as sources of phosphoric acid; the nature and general composition of the different phosphates; the selection of phosphoric acid fertilizers; fertilizers used chiefly as sources of potash; complete fertilizers; indirect fertilizers; fertilizer laws and guaranties; experiments as a means of determining whether fertilizers may be profitably used; plan for farmers' experiments with fertilizers; different systems in accordance with which fertilizers may be used; green manuring; farm crops; crop rotation; systems of rotation; methods of propagating plants; seed propagation; planting seeds; the plant; mowings and pastures; perennial grasses; perennial clovers and alfalfa; seeding and care of mowings; annual forage crops for hay, soiling, folding, or ensilage; crops cultivated for their seeds; crops cultivated for underground parts; tubers; bulbs.

Volume III. Animal husbandry, including the breeds of live stock, the general principles of breeding, feeding animals; including discussion of ensilage, dairy management on the farm, and poultry farming. Animal husbandry; stock farming; breeds of live stock; neat cattle; dairy breeds; beef breeds; dual purpose breeds; horses; breeds of horses valuable for their speed; draft horses; carriage and coach breeds; ponies; mules; sheep; short-wooled sheep; middle-wooled breeds; long-wooled breeds; swine; large breeds of hogs; middle breeds; small breeds; the hog on the farm; general principles of stock breeding; heredity; variation; fecundity; in-breeding; cross-breeding; relative influence of parents; influence of previous impregnations; mental influences and nervous impressions; the selection of individual animals for breeding; details of stock breeding; the principles and practices of feeding; composition of the animal body and of the animal products; composition of foods; functions of nutrients; digestibility; feeding standards; cattle foods; silage; straws; roots and tubers; grains and seeds; by-products; feeding in summer; dairy husbandry; milk; good cows essential to profitable milk production; conditions essential for the production of good milk; means whereby milk is contaminated after leaving the cow; disposal of dairy products; milk and cream for market; cream; butter making; poultry farming; barnyard fowls; American breeds; Asiatic class; Mediterranean class; French fowls; English fowls; games; general care of fowls; the raising of chickens; turkeys; ducks; breeds of ducks; geese.

1901. FRANCIS WATTS. *Nature Teaching*. Based upon the general principles of agriculture for the use of schools. Issued under the authority of the Commissioner of Agriculture for the West Indies. Dulau & Co., London; Bowen & Sons, Bridgetown, Barbados. Pp. 199.

Chapter I, The Seed; Chapter II, The Root; Chapter III, The Stem; Chapter IV, The Leaf; Chapter V, The Soil; Chapter VI, Plant Food and Manures; Chapter VII, Flowers and Fruits; Chapter VIII, Weeds; Chapter IX, Insects. Glossary. Appendices.

1902. F. P. SEVER. *Elements of Agriculture, with Industrial Lessons.* D. C. Heath & Co., Boston. Pp. 141.

Part I: Chapter I, Domestic Animals and Fowls (Lesson 1, Rover, a St. Bernard; Lesson 2, The Horse; Lesson 3, The Horse, continued; Lesson 4, Among the Poultry; Lesson 5, Among the Poultry, continued); Chapter II, In the House, In the Garden, and In the Store (Lesson 6, Helping Mother; Lesson 7, Helping Mother, continued; Lesson 8, Grandfather's Garden; Lesson 9, Grandfather's Garden, continued; Lesson 10, Helping in the Store).

Part II: Chapter III, In the Country (Lesson 11, Farm Economy; Lesson 12, Farm Dairying; Lesson 13, The Farmers' Friends—Do You Know Us?; Lesson 14, In the Orchard); Chapter IV, The Soil (Lesson 15, Story of the Soil; Lesson 16, Story of the Soil, continued); Chapter V, Plants, Field Crops (Lesson 17, The Fairies in the Trees; Lesson 18, The Little Ear and Its Big Friend; Lesson 19, Cotton; Lesson 20, Wheat; Lesson 21, Rice; Lesson 22, Tobacco); Chapter VI, Conclusion (Lesson 23, Little Things).

1903. CHAS. E. BESSEY, LAWRENCE BRUNER, G. D. SWEZEY. *New Elementary Agriculture for Rural and Grade Schools.* An elementary text-book dealing with the Plants, Insects, Birds, Weather, and Animals of the Farm. The University Publishing Co., Lincoln, Nebr. Pp. 194.

Chapter I, What is a Plant and What is It Doing?; Chapter II, How the Farmer can Use the Plant; Chapter III, Different Classes of Farm Plants; Chapter IV, The Important Farm Crops; Chapter V, The Insects of the Farm; Chapter VI, Useful Insects; Chapter VII, Harmful Insects; Chapter VIII, Birds; Chapter IX, Other Wild Animals; Chapter X, The Weather of the Farm; Chapter XI, The Wind; Chapter XII, Cloudy and Rainy Weather; Chapter XIII, Storms; Chapter XIV, Weather Predictions; Chapter XV, The Soil; Chapter XVI, Domestic Animals of the Farm; Chapter XVII, Cattle; Chapter XVIII, Swine; Chapter XIX, Sheep; Chapter XX, How to Care for Live Stock.

1903. CHARLES WILLIAM BURKETT, FRANK LINCOLN STEVENS, DANIEL HARVEY HILL. *Agriculture for Beginners.* Ginn & Co., Boston and London. Copyright 1903. Pp. 267.

Chapter I, The Soil; Chapter II, The Soil and The Plant; Chapter III, The Plant; Chapter IV, How to Raise a Fruit Tree; Chapter V, the Diseases of Plants; Chapter VI, Orchard, Garden, and Field Insects; Chapter VII, Farm Crops; Chapter VIII, Domestic Animals; Chapter IX, Farm Dairying. Appendix. Glossary.

1903. UNIVERSITY OF MINNESOTA, Willet M. Hays, Editor. *Exercises in Agriculture and Housekeeping for Rural Schools.* St. Paul, Minn. McGill-Warner Co. Pp. 196.

This is "Bulletin No. 1," issued under State auspices by the department of agriculture of the University of Minnesota. The cover is stamped "Rural School Agriculture. Bulletin No. 1, Practical Exercises." The book contains 237 separate exercises, each one signed by its author, from which the teacher may choose available material. The University was intrusted, in 1901, by the State legislature, "with the work of helping to introduce the subjects of agriculture and household economies into the rural schools of the State." The following extracts from the preface explain how the work was undertaken: "At a meeting of the board of regents, June 4, 1902, the full administration of this whole matter was assigned to

Regent Liggett. Prof. W. M. Hays was put in charge of the work. Mr. J. F. Wojta, M. Agr., of the University of Wisconsin, was elected by the board of regents as assistant in agriculture to aid in this work. Prof. Wm. Robertson, instructor in agricultural physics in the School of Agriculture, was temporarily employed to assist during a part of the summer. The first bulletin prepared under this law has been jointly edited by Messrs. Hays, Robertson, and Wojta. The exercises have been prepared by these gentlemen and other members of the department of agriculture of the University of Minnesota, to be distributed in cooperation with the State department of public instruction."

1903. JAMES B. HUNNICUTT. *Agriculture for the Common Schools.* Atlanta, Ga. The Cultivator Publishing Co. Pp. 225.

Chapter I, Man's Chief Pursuit; Chapter II, Agriculture as a Science; Chapter III, Something of the History of Agriculture; Chapter IV, The Soil; Chapter V, Composition and Kinds of Soil; Chapter VI, Uses of the Soil; Chapter VII, The Soil as a Workshop; Chapter VIII, Preservation and Improvement of the Soil; Chapter IX, Other Points About Soil; Chapter X, Plants—How They Grow; Chapter XI, Uses and Abuses of Water on the Farm; Chapter XII, Plants and the Atmosphere; Chapter XIII, Manures and Fertilizers; Chapter XIV, How to Use Manures and Fertilizers; Chapter XV, Planting; Chapter XVI, Selecting Seed; Chapter XVII, Preparing the Soil for Planting; Chapter XVIII, Cultivation; Chapter XIX, Gathering and Housing; Chapter XX, Marketing Crops; Chapter XXI, Investing Profits; Chapter XXII, Farm Labor; Chapter XXIII, Farm Implements; Chapter XXIV, Farm Animals; Chapter XXV, Grass Culture; Chapter XXVI, Truck Farming; Chapter XXVII, Dairy Farming in the South; Chapter XXVIII, Stock Growing; Chapter XXIX, Poultry Farming; Chapter XXX, Bee Keeping; Chapter XXXI, Farm and Public Roads; Chapter XXXII, Farm Buildings; Chapter XXXIII, Village Farming; Chapter XXXIV, Forestry; Chapter XXXV, The Farmer as a Citizen; Chapter XXXVI, The Farmer Should be Educated. Appendix—Useful Tables.

AGRICULTURAL ECONOMICS AS A SUBJECT OF STUDY IN THE AGRICULTURAL COLLEGE.

By KENYON L. BUTTERFIELD, A. M.,

President of the Rhode Island College of Agriculture and Mechanic Arts.

The writer has been asked to make suggestions relative to the teaching of what is coming to be called agricultural economics, with special reference to its place in the curriculum of the agricultural college. With the practical object in mind of endeavoring to outline work which may be pursued under this head, it is not desirable to discuss at length the reasons why the subject should be given attention. These reasons lie deep in the foundation of sound agricultural education, and, indeed, involve our whole educational structure. But it may not be out of place merely to indicate the direction such a discussion might take.

It may be observed, in the first place, that the aim of agricultural education has been, in large measure, to help the farmer to secure larger crops of choicer products at less cost. It has involved the application of the principles of the natural sciences to the physical problems of the farm. This of course is fundamental, but nevertheless partial. Agriculture is something more than the growing of things, and something more than the growing of more things more cheaply. And it is not a far cry from the admission of this fact to the acknowledgment that the agricultural course shall discuss those problems that go beyond the scope of studying science in relation to the soil, the plant, and the animal.

It may be urged that this need of broader instruction is being met by the study of farm management, for this subject includes a discussion of those questions that look toward the disposal of the crops, the general administration of the farm, and the relation of the farmer to the business world. Farm management is bound to occupy an increasing share of time in the agricultural course, at least so long as that course attempts to train farmers. But farm management discusses the aspects of agriculture as a business and approaches agriculture from the standpoint of the individual farmer; while agriculture is something more than a business, it is an industry.

And because agriculture is an industry and indeed ranks among the leading industries, it is related to all other industries and must be con-

sidered in those relations. It is not an isolated occupation. It is subject to economic laws. It prospers or lags, not merely because of its internal phases, so to speak, but also because of its external relations. It should therefore be studied as an industry as well as an art and a business and approached from the economic standpoint.

And, finally, it may be said that the social point of view is absolutely necessary in agricultural as in all other education. Indeed, I question if it is not true that the great educational problem of the near future is to be not the conflict between cultural and vocational education, but the conflict between the technical preparation of the man as an expert and the proper training of that same man for his high duties, both political and social, in the community life. Agricultural economics should lead the student to the social viewpoint.

This sketchy statement is hardly worthy the name of an argument for the study of agricultural economics and will not be presented as a formal plea for adopting this study, but it is possible that it may hint at the fundamental nature of the reasons that lie back of this movement.

Until the material to be presented in the teaching of this subject is better organized than it is at present, a definition of agricultural economics ought to be provisional. Any definition is likely to be unsatisfactory from some point of view. Perhaps the boundaries of this subject could best be defined by indicating what lies outside of them, but contiguous to them. However, agricultural economics may be said to be the study of agriculture as an industry, using the word industry in its wide, economic sense. It is a discussion of agriculture in the light of the principles of political economy. It is the application of industrial or economic laws to the problems of the farmer. It may be distinguished from rural sociology in that the latter is the study of the social conditions under which farmers live and the social institutions that minister peculiarly to the farmers' welfare. It may be distinguished from farm management in that the latter discusses the business and commercial phases of agriculture viewed from the standpoint of the individual farmer. Agricultural economics will impinge upon rural sociology at numerous points, because, in a full analysis, the economic and the sociological can not be entirely divorced. It may impinge upon farm management even more frequently, because many of the subjects of discussion are the same, although there is a wide difference in the point of view from which the subjects are approached and in the method of treatment.

It ought to be said that no claim will be made for agricultural economics as a new science, nor is it likely that those who carry on researches under its name or who teach its subject-matter will contribute materially to economic theory. Its method will be frankly descriptive rather than theoretical. But this fact need not detract

from its value or dignity, because it is clearly evident that in modern economic study a large share of the best work is being done by those who are studying existing conditions.

There is another consideration of some importance. The subject ought to be presented by an economist rather than by an agriculturist, because the subject-matter is primarily economic and not agricultural. But the economist who teaches this subject should be a man in thorough sympathy with practical agriculture and able to approach his subject from the standpoint of the actual conditions and needs of the agriculture of this country. Where it is not at present feasible to employ a specialist for the work, the teacher of agricultural economics should at least have had a thorough grounding in economics. I trust that the little band of keen-sighted professors of agriculture who have been wise enough within very recent years to give courses bearing on this general subject will take no offense at this statement. I am speaking ideally. Ultimately, specialists in economics connected with the land-grant colleges must do this work. They have at hand splendid opportunity for labor in a field which is almost virgin soil.

Ideally, again, the study of agricultural economics would not be an isolated subject, but would be a feature of a lengthened study of social science, extending over two or three years' time, with a fair preparation in the principles of economics and sociology and politics, followed by some consideration of the more important problems of the day that are economic, sociological, and political. With this general preparation the student could then well spend at least one year in the study of agricultural economics and rural sociology. The immediate task, however, is that of endeavoring to outline what might be given in a course of agricultural economics to occupy a period of perhaps three hours per week for a term of from twelve to twenty weeks.

It is hoped that the appended outline may be suggestive of what can easily be given in the average agricultural course of the land-grant colleges. It is not designed to be a final analysis of the subject of agricultural economics.

OUTLINE FOR A SHORT LECTURE COURSE IN AGRICULTURAL ECONOMICS.

I. Characteristics of the agricultural industry.

Dependence upon nature.

Capital and labor as applied to agriculture.

The laws of rent and of decreasing returns in agriculture.

Relation of agriculture to other industries and to the welfare of mankind.

II. History of the agricultural industry.

In ancient times.

Status in Europe prior to the eighteenth century.

The struggle to maintain its standing after the advent of commerce and manufacture.

II. History of the agricultural industry—Continued.

In the United States.

The pioneer stage.

Development of commercial agriculture.

The new farming.

III. Present status of the farming industry.

The world's food supply.

Agricultural resources of the United States.

Geographical factors.

Soil, climate, fertility, natural enemies.

Statistics of farms, farm wealth, production, etc.

Leading subindustries—cereals, stock, etc.

Distribution of production.

IV. The agricultural market.

Description of the market—local, domestic, foreign.

Mechanism of the market.

Banks and local exchange facilities.

Middlemen.

Boards of trade.

Prices of agricultural products.

Movements of.

Agricultural competition.

Depressions in agriculture.

Influence of "options."

Transportation of agricultural products.

Primary transportation—wagon roads and trolley lines.

Railroad and water transportation.

Facilities.

Rates.

Discriminations.

Delivery methods.

Incidents of the transportation system—elevators, etc.

Imperfect distribution of agricultural products.

Development of the market.

Increase of consumption of products—manufacture of farm products as a factor.

The factor of choicer products.

The factor of better distribution of products.

The local market as a factor.

The foreign market as a factor.

V. Business cooperation in agriculture.

Historical sketch.

Present status.

Production.

Marketing.

Buying.

Miscellaneous business cooperation.

Difficulties and tendencies.

VI. Agriculture and legislation.

Land laws and land policy of the United States.

Agriculture and the tariff.

Agriculture and monetary legislation.

Taxation and agriculture.

Food and dairy laws.

Government aid to agriculture.

VII. Some current problems.

- Agricultural labor.
- Machinery and agriculture.
- Interest rates, indebtedness, etc.
- Tenant-farming.
- Large versus small farming.
- Business methods.
- Immigration and agriculture.

If time permits, and the students have had adequate preparation in general economics, it would be profitable to dwell at some length upon the first two chapters of the outline. In the first the industry of agriculture may be described in economic terms and its economic character fully analyzed. In the second one could well spend some time in discussing the development of agriculture and its changing relations to other industries. But in the ordinary course likely to be given to agricultural students it will hardly be wise to do more with these topics than to make them a slight foundation for the subsequent descriptive work. It will be observed that American conditions naturally form the point of view of this outline.

The most serious difficulties in offering this subject will arise in those institutions where the agricultural course is relatively inflexible and where the elective system has made small headway. Here the prime objection will be, "There is not time." It may be urged in reply that this same objection has been raised against almost every study that has been introduced in the last twenty years. But in spite of the objection the new subjects flourish and multiply exceedingly. Perhaps it will be a rather harsh and unsatisfactory answer to this objection to say, "Take time." Of course, if the subject is not more important than something else, it will be difficult to find a place for it in this inflexible curriculum. But if agricultural educators once concede the importance of the subject, a place will be made for it.

Another objection will arise through the contention that there is "no body of knowledge" that has been put into pedagogical form relating to this subject. That is true. It was true ten years ago of a score of subjects which are now taught successfully in our agricultural courses. Theoretically, it is a powerful objection; practically, it never long stands in the way of adopting a new course of study. There is already abundance of material at hand for a moderately satisfactory course in agricultural economics. The recent publications of the Department of Agriculture, the various reports of governments and States, the Federal census, the files of our best farm papers, and finally the valuable reports of the Industrial Commission, are easily accessible. All this information needs digesting and arranging, but it is far from being in a chaotic condition, and the requisite "body of knowledge" can be fairly well organized without serious difficulty. It may be said in passing, however, that no phase

of economics or sociology offers a richer field for investigation than does agriculture.

The request which came to me for this article said specifically that a discussion of possible work in agricultural economics was desired. I can not refrain, however, in closing, from making a plea for a broader view of the question and for urging agricultural educators to consider as a unit the whole subject of what, for want of a better term, we may call rural social science, and therefore to permit just as much attention to the study of rural sociology as to the study of agricultural economics. We need more well-equipped leaders on the farm, and these leaders will find that the questions confronting them are in no small degree sociological. Farmers' organizations, better communication in rural districts, the country school, the country church, all the broad phases of agricultural education, are pressing problems in each farm community. They need the leadership of trained minds. Viewed in all broader aspects, these sociological questions are of the greatest importance. Indeed, if I had to choose between a course in rural sociology and a course in agricultural economics, taking as a standpoint the need of the man who is getting his training in an agricultural college as a future farmer, I would be inclined to sacrifice the agricultural economics, because I believe that the adequate development of the social agencies for progress in rural life is of vital and immediate concern. If, however, the course in rural sociology can not be given, I would urge that a chapter be added to the outline submitted above, somewhat as follows. This will serve at least to call attention to the importance of the sociological factor in rural progress:

VIII. Some sociological factors influencing the industry of agriculture.

Movements of the farm population.

Improvements in communication in rural districts—trolleys, telephones, mail delivery, roads.

The country church.

The rural school.

Agricultural education.

Farmers' organizations and societies.

Cooperation of the factors.

INSTRUCTION IN AGRICULTURE IN LAND-GRANT COLLEGES AND SCHOOLS FOR COLORED PERSONS.

By D. J. CROSBY,

Office of Experiment Stations.

The land-grant colleges for colored persons, which are supported mainly by National and State funds, constitute a class by themselves. In their organization and work they differ in so many respects from the land-grant colleges for whites that the general statements made regarding these colleges, considered as forming one system of educational institutions, are often misleading. Much has been written about the facilities for agricultural education and the methods of instruction in agriculture in the land-grant colleges generally which is not really applicable to these institutions for the colored people of the South. It has therefore seemed desirable to give a separate account of the opportunities offered these people for instruction in agriculture in the land-grant institutions set apart by law for their race. It is intended to show (1) the requirements for admission to these institutions, (2) the number and character of courses offered and the degrees given, (3) the extent and character of instruction in agriculture, including, also, statements regarding the facilities for such instruction, and (4) some statistics showing the revenues, value of equipment, and number of students in these institutions. Incidentally, they will be compared collectively in certain of their features with similar institutions for white persons in the same States.

There are 16 of the so-called "land-grant" colleges and schools for colored persons, though, as a matter of fact, only 4 of them participate in the benefits of the land-grant act of 1862. All, however, receive funds provided by the act of 1890, the amounts received by the different institutions being determined by the ratio of colored to white persons in the States establishing separate schools for the two races. In one State (Mississippi) the colored agricultural and mechanical college receives a larger percentage of the "second Morrill fund" than that for white persons. The total revenue of the colored institutions in the fiscal year 1902-3 was \$537,738.45. Of this amount \$205,554.94 was received from the Federal Government, \$159,264 from the States, and \$172,919.51 from fees and other sources. The largest revenue (\$194,046.96) was received by Hampton Normal and Agricultural

Institute, and the smallest (\$9,005.49) by the Delaware State College for Colored Students. The average total income per student was \$88; that of the white colleges was \$173—nearly twice as much.

The equipment of these institutions is valued at nearly \$2,000,000, of which 67 per cent is represented by buildings. The approximate total value of farms and grounds is \$300,000; of apparatus, \$41,400; of machinery, \$83,300; of libraries, \$30,400, and of live stock, \$27,600. More than half of the live stock is owned by one institution—the Hampton Institute. That these institutions are gaining in wealth is shown by the fact that more than 8 per cent of their total equipment has been added during the past fiscal year. And yet, with two-thirds as many students as the land-grant colleges for whites, these institutions have an equipment valued at less than one-third that in the colleges for whites.

The total number of students in the colleges and schools for negroes in 1902-3 was 6,080; the number of graduates, 422; the number of degrees conferred, 119; the number of instructors, 346. There were 14.4 students for each graduate; 51 students for each graduate from a degree course; 17.6 students for each instructor. In the colleges for whites in these States there were 9,171 students; 608 graduates; 608 degrees; 15 students for each graduate; 15 students for each graduate from a degree course, and 14.4 students for each instructor. In material equipment then—income, buildings, land, apparatus, machinery, and number of instructors—the colleges for whites are relatively much better off than those for negroes. On the other hand, the latter institutions graduate a larger percentage of those enrolled than do the former.

The statistics show that 71 per cent of the students in the negro institutions were in the preparatory courses and only 12 per cent in the collegiate courses. But of the graduates of these institutions only 28 per cent received bachelors' degrees, and, furthermore, 269 (nearly 36 per cent) of the students reported as being in collegiate courses were in attendance at an institution which is admittedly a secondary school and grants no degrees; so it is safe to assume that not more than three or four per cent of the students in the land-grant colleges for negroes were in four-year courses leading to bachelors' degrees. This, in itself, is not to be taken as an unfavorable criticism of the institutions, except in so far as the figures are slightly misleading, for it is known that much of the most useful work done by them is done in the secondary and special courses; but it is an indication of the grade of instruction that must be provided for nearly all of the people served in these colleges and schools.

Most of these institutions are doing their utmost to meet the real, most urgent, and most immediate needs of the young people within

their doors and to guide aright those who have gone out from the shadow of the college walls to labor among their people. And they are succeeding in their mission in just such proportion as they have inculcated lessons of temperance, morality, industry, and dignity of service, whether it be labor of the hands or of the head.

And yet there are some among the teachers in these schools who seem to forget that a child "must creep before it can walk," who would teach the classics and the higher mathematics and theology and international law to the exclusion of a thorough grounding in English, arithmetic, and the industrial arts; who forget that it is the "mission" (and it may be a most honorable mission, a most high calling) of the great majority of all the people, both black and white, to labor, to be producers. And these teachers are the ones who send out "kid-gloved" graduates to lives of miserable failure, whether it be as instructors and leaders among their people, or as producers of the necessities and comforts of life.

In general, however, it may be said that considering their limited resources most of the negro schools endowed by the Federal Government are making an honest effort to offer their students good opportunities for training along industrial lines. As regards agriculture, this is shown by the fact that all but one of them are teaching agriculture and more than one-fourth of all the matriculates in these schools are taking agricultural courses of some sort. This is a good showing, when it is considered that so many of those enrolled are in primary and grammar grades—when 71 per cent of all the students are in preparatory courses. It is a better showing by over 15 per cent than similar institutions for whites in the same States are making with only 14 per cent of preparatory students. This is not intended to be a comparison of the quality of instruction, but of the number taking agriculture as shown by official returns from each institution.

It is likely that in the agricultural colleges for whites more pedagogical courses and higher grades of instruction in agriculture are found, and it would be strange if this were not true. The negro, like the white man, has had to evolve his own courses in agriculture, but the latter has had the advantage of long experience in educational work, while the former is but 40 years from slavery. He has had textbooks, but not the inspiration and guidance of experienced teachers. He has had the example of his white neighbor, but not the benefit of that white neighbor's agricultural college, except in the rare cases where one of his own race has been trained in the colleges of the North. So, while we must admit that the Southern agricultural colleges and schools for negroes have many shortcomings and many needs, a careful study of the whole situation must convince us that the outlook is, on the whole, very encouraging, that earnest and noble

effort is meeting its reward in the upward trend of educational methods and in the more wholesome attitude of the negro race toward industrial education.

And yet, optimistic as we may be, we should not lose sight of the fact that the institutions under consideration have many needs. Some of the more prominent of these needs as regards instruction in agriculture may be summed up as follows:

(1) Better instructors: These should be better trained in up-to-date methods of teaching agriculture and should have a broader and more hopeful view of the agricultural situation than is now prevalent in these institutions. They should be primarily teachers of agriculture; not teachers of chemistry or botany as related to agriculture. It would also be infinitely better if they could broaden their horizon by taking postgraduate work in some other college than the one from which they graduate.

(2) Better text-books of agriculture: Many of those now in use are antiquated. At one time they were comparatively sound, but later and better books have appeared and should speedily replace those not thoroughly suited to the more modern method of teaching agriculture.

(3) Better library facilities: Few of these schools have anything like adequate reference libraries. The total value of their libraries (\$30,396) is less than that of single libraries in many of the agricultural colleges for whites.

(4) Better laboratory facilities: Only two or three of these institutes have any laboratory equipment for teaching agriculture.

(5) Better farm buildings, live stock, machinery, and other equipment: Some of these schools have farms with thoroughly modern equipment and are practicing diversified farming, but they are the exception to the general rule.

(6) More liberal funds: It has been shown above that the income per student of the colored schools is scarcely more than half that of the colleges for whites. It will hardly be possible to make much improvement in their staff of instruction and material equipment until they have better financial support.

(7) Better methods of instruction: These will surely come and can only come when the other needs are more or less fully supplied. With better-trained instructors, better text-books and library facilities, better laboratory and farm equipments and methods, we shall speedily have in these schools better methods of instruction and a more rational attitude toward the fundamental industry of the South.

Detailed statements regarding the facilities and methods of instruction in agriculture in the different colleges and schools for negroes in the South are given below. An article by C. L. Goodrich describing the methods of instruction in agriculture in Hampton Normal and Agricultural Institute is given on page 739.

ALABAMA.

Agricultural and Mechanical College of Alabama for Negroes, *Normal*.

The Agricultural and Mechanical College offers a preparatory course of three years, a normal course extending over four years, an English primary course of three years, the pupils in which constitute a practice school for normal students, and three collegiate courses of four years each, viz: The agricultural course leading to the degree of bachelor of agricultural science; the mechanical course leading to the degree of bachelor of mechanical science, and the scientific course leading to the degree of bachelor of science. There are also industrial courses in carpentry, iron making, shoe making, broom making, chair bottoming, nurse training, sewing, millinery, cooking, laundering, printing, etc.

Candidates for admission to the college and normal courses must present satisfactory evidence of good moral character and must be not less than 15 years of age. Younger persons of good moral character are admitted to the preparatory course and a limited number of children of any age into the English primary course.

Agriculture and mechanics are taught throughout the first two years of the normal course. The agricultural course includes solid geometry, five hours per week for one term; structural, physiological, and field botany, daily throughout the freshman year; agricultural chemistry, daily throughout two terms of the freshman year; qualitative analysis, throughout one term; comparative physiology, one term in the sophomore year; veterinary hygiene, one term in the sophomore year; geology, two terms in the junior year; mineralogy, entomology, and human anatomy, one term each in the junior year; general physics and zoology, two terms each in the junior year; political economy, two terms in the senior year; climatology, moral science, and meteorology, one term each in the senior year, besides the agricultural subjects, which are as follows: History of agriculture, drainage and irrigation, fertilizers, and stock breeding, one term each in the sophomore year; truck farming and horticulture, one term each in the junior year; forage plants, forestry, review of the United States Department of Agriculture bulletins, spraying of plants and agricultural engineering, one term each in the senior year. "Experimental work" occurs daily throughout the course.

The industrial course in agriculture extends over three years and is described in the catalogue of the institution as follows:

FIRST YEAR—FIRST TERM.

Lectures on soils, plants, domestic animals, and management of live stock and dairy. Goff's Principles of Plant Culture.

SECOND TERM.

Diseases of live stock and domestic animals; practical gardening and management of live stock and dairy.

SECOND YEAR—FIRST TERM.

Discussion of soils—their formation and classification, their physical defects and remedies; dairy farming continued.

SECOND TERM.

Lectures on the means to protect the soil from waste and restore fertility; artificial and green fertilizers.

THIRD YEAR—FIRST TERM.

Practical gardening; floriculture and horticulture; farm drainage; planting and raising of grains, grasses, etc.

SECOND TERM.

Poultry, sheep, and cattle raising; management of dairy continued; pruning, grafting, and budding; bee culture and lectures on political economy.

Instruction in agriculture is given by the professor of agriculture and one assistant. The buildings of the college comprise seven large college buildings, a number of smaller buildings, a new barn and dairy, and several of the old buildings that were on the farm before it was purchased for college purposes. The farm consists of nearly 200 acres of land on the Meridianville pike, about 4 miles north of Huntsville. It is well stocked with mules, horses, Devon and Jersey cows, hogs, poultry, vehicles, and implements. There is also an orchard containing all the leading fruits of the region; a laboratory containing chemical, biological, and other apparatus, and a library of choice books, magazines, and journals. The different industrial departments are also provided with suitable reference books and text-books, and the literary and scientific departments with encyclopedias and other books to which all the students have access.

ARKANSAS.

Branch Normal College, *Pine Bluff*.

This college is a department of the University of Arkansas, established in 1873 for the purpose of training teachers for the public schools of the State. The courses of study include a two-year preparatory course, a four-year normal course which comprises two years of college preparatory work and two years of college work, and a classical college course of four years. Graduates of the normal course are granted the degree licentiate of instruction, and of the classical course the degree bachelor of arts. For admission to the normal course candidates, if young men, must be at least 16 years of age, and if young women 14 years of age, and must pass satisfactory examinations in arithmetic, English grammar, geography, and United States history.

Instruction in agriculture is not included in the curriculum of the college. All students are required to spend ten hours a week in sewing, typewriting, or shop work.



FIG. 1.—INSTRUCTION IN AGRICULTURE FOR NEGROES—FLORIDA STATE NORMAL AND INDUSTRIAL SCHOOL, STUDENTS THRASHING RYE.



FIG. 2.—INSTRUCTION IN AGRICULTURE FOR NEGROES—FLORIDA STATE NORMAL AND INDUSTRIAL SCHOOL, STUDENTS SHREDDING CORN.



FIG. 1.—INSTRUCTION IN AGRICULTURE FOR NEGROES—FLORIDA STATE NORMAL AND INDUSTRIAL SCHOOL, DAIRY HERD.



FIG. 2.—INSTRUCTION IN AGRICULTURE FOR NEGROES—FLORIDA STATE NORMAL AND INDUSTRIAL SCHOOL, POULTRY.

DELAWARE.

State College for Colored Students, Dover.

This college offers a four-year classical course leading to the degree bachelor of arts, a four-year scientific course leading to the degree bachelor of science, a four-year engineering course leading to the degree bachelor of engineering, and a four-year agricultural course leading to the degree bachelor of agriculture. In addition there is a normal course of three years, the graduates of which receive certificates recommending them as teachers in the public schools of the State, and a two-year preparatory course.

Applicants for admission to the college course must be at least 14 years of age and be able to pass a satisfactory examination in reading, writing, spelling, arithmetic, English grammar, and history of the United States, except in the classical course, where additional tests in rhetoric, algebra, and English classics are required. Students are admitted to the preparatory and normal courses without examination.

The first two years of the agricultural course is the same as the scientific course and include mathematics, botany, anatomy, biology, physical geography, English, history, chemistry, zoology, mineralogy, and Latin. The agricultural subjects of the junior and senior years include breeding, drainage, feeding, vegetable physiology and pathology, dairying, fruit culture, horticulture, and physics of the soil. The agricultural faculty consists of one instructor in practical agriculture. The agricultural students are required to take practical work in agriculture and horticulture averaging two hours a day. Laboratory practice is an important feature of instruction in botany, zoology, chemistry, and physics. The library of the college contains several hundred volumes.

The college is located 2 miles north of Dover on the Loockerman farm, a tract of about 100 acres containing, in addition to the college buildings, a number of farm buildings and greenhouses, orchards, and small fruit plantations.

FLORIDA.

The Florida State Normal and Industrial School, Tallahassee.

This institution includes a preparatory school and a normal school. The work of the school is organized in three departments—academic, agricultural, and mechanical—and boys who receive diplomas are required to complete the academic work and either the agricultural or the mechanical work, which are features of each term's work in both the preparatory and the normal course.

Applicants for admission to the normal course must be 16 years old,

and, in addition to being able to read and write, must have a fair knowledge of arithmetic, English grammar, and descriptive geography. No degrees are conferred. Graduates of the four-year normal course receive diplomas which entitle them to first-grade certificates without examination.

Agronomy, horticulture, animal husbandry, dairying, agricultural engineering, and rural economy are studied by the regular agricultural class. Each subject is taken up by quarters and is given during two or three forty-minute periods a week. Short courses in botany and agricultural chemistry are given in connection with the agricultural work. Instruction is largely by means of lectures. The textbooks used for the class room and reference purposes include the *Principles of Agriculture for Common Schools*, Winslow; *First Principles of Agriculture*, Voorhees; *The Principles of Plant Culture*, Goff; *Botany*, Bailey; *Common-Sense Ideas for Dairymen*, Blake; *Feeds and Feeding*, Henry. The students have free access to a library containing Government bulletins and periodicals and a few agricultural papers.

Students are required to collect soils and experiment with them in glass boxes. They also spend three hours a day in field work (Pl. LIV, figs. 1 and 2). The instructors having charge of the agricultural work include a science teacher, a teacher of dairying, and a teacher of poultry raising and practical farm work. The building used for agricultural classes contains two small rooms used for dairying and one for the class room. The dairy rooms are equipped with separators, milk testers, butter workers, scales, fertilizers, churns, cream vats, and a refrigerator.

The college farm contains about 160 acres, upon which are grown peas, corn, potatoes, millet, sugar cane, oats, rye, and garden vegetables. Some experiments have been made with legumes. The farm animals include 2 mules, 4 horses, 16 dairy cows (Pl. LV, fig. 1), a Jersey bull, about 40 head of hogs, and 75 or 80 chickens (Pl. LV, fig. 2). Students are required to do all the field work.

GEORGIA.

Georgia State Industrial College, *College*.

This college is a department of the State university. The courses of study offered are the industrial, three-year preparatory, three-year normal, and four-year collegiate. For admission to the college, students must be not less than 14 years of age, of good moral character, and able to pass "an entrance examination."

Agriculture does not appear in the curriculum as a subject for study and recitation, but is given as an industrial subject. Students are given employment and instruction on the farm and in the dairy. There is a

special dairy course given during two months in the winter, which includes instruction in the care of the dairy herd, feeds and feeding, milk as a food, dairy machinery, butter making, and general care of a modern dairy. This instruction is given by the foreman of the farms.

A library of about 600 volumes is available for the students. The college buildings include a dormitory, two school buildings, farmhouse, blacksmith shop, wheelwright and carpenter shops, and four cottages for the faculty. The campus contains about 35 acres and the college farm 51 acres. The latter is fairly well equipped with agricultural implements, and contains a dwelling for the superintendent and a barn.

KENTUCKY.

The Kentucky Normal and Industrial Institute for Colored Persons, *Frankfort.*

The courses of study offered include a three-year preparatory course, a three-year normal course, and a four-year teacher's course. Candidates for admission must be at least 16 years of age, possess good health, good moral character, and sign a written pledge to teach so far as practicable in the common colored schools of Kentucky a period equal to twice the time spent in the school.

Agriculture is not taught in the normal department, but is one of the features of the industrial department. All young men must work one hour a day, and those choosing agricultural work are given instruction in dairying, soils, seeds and growth of plants, flowers, fertilizers and fertile soil, cultivation of the soil, rotation of crops, farm animals and implements, and other agricultural subjects. The library contains Johnson's *How Crops Feed* and *How Crops Grow*; Storer's *Agriculture*, and the publications of the Department of Agriculture. The farm contains 300 acres and affords excellent opportunities for work, many of the students earning enough to defray their expenses. There are a number of farm animals, including a herd of Holstein and Jersey cattle.

LOUISIANA.

Southern University and Agricultural and Mechanical College, *New Orleans.*

The Southern University is divided into six departments as follows: (1) College, offering four-year classical and scientific courses. (2) Normal school, offering a three-year course. (3) High school (college preparatory), four-year course. (4) Grammar school, three-year course, including sixth, seventh, and eighth grades. (5) Department of music. (6) Industrial department, including agricultural school, mechanical school, girls' industrial school, dairy school, school of printing, and school of bookkeeping and typewriting. Any colored resident of Louisiana may be admitted to the university after examination, and will be classified according to his attainments.

The agricultural and mechanical departments have been organized since 1890. The agricultural course is a secondary course corresponding in grade to the college preparatory course. The class-room work consists very largely of instruction in agricultural chemistry to which three hours per week are devoted during the first and second years, five hours during the third year, and review work during the first term of the fourth year. The subjects treated in this connection include organic and inorganic substances, the relation of air and water to soil, germination of seeds, drainage, manures and fertilizers, classification of plants, farm crops, chemical affinity and chemical decomposition, formulas of compounds, vegetable organic compounds, reproductive organs of plants, etc. Carried along with this work is the practical work in field, laboratory and farm buildings, five to fourteen hours per week. Attention is given to the application of fertilizers, care, breeding, and feeding of stock, dairying, truck farming, and fruit culture. The dairy school has been in operation on the farm since 1896. The course covers two years. Instruction is given by the superintendent of the agricultural section.

A library of some 4,000 volumes is available to all students, as are also a number of periodicals and a fairly representative list of modern text-books on agricultural subjects.

The principal buildings at the university—those in which the academic instruction is given—are located in the city of New Orleans. One of these is the laboratory building for chemistry and physics in which instruction in agricultural chemistry is given. A second group of buildings is on the university farm, 4 miles up the river from the city limits. These include the old plantation buildings, dwellings for workmen, a two-story frame dormitory and dairy building, barns and hog house, stable for cows and horses, and other farm buildings. The farm consists of about 100 acres of Mississippi River alluvium upon which all the staple crops of the region are grown. It is stocked with 7 Jersey and Holstein cows, a Jersey bull, 2 horses, 4 mules, 11 hogs, and 100 fowls.

MARYLAND.

Princess Anne Academy, Princess Anne.

Eastern Branch of Maryland Agricultural College.

This is a secondary school devoted largely to the preparation of students for Morgan College, in Baltimore, with which it is associated. The courses of study offered include a normal preparatory course, a secondary academic course of four years, and a normal course of four years, differing from the academic course only in the subjects of instruction during the last two years. Academic and normal students are required to spend not less than three hours per day in "industrial experiment."

The industrial course includes agriculture, and the subjects considered under this head are soils, seeds, fertilizers, seeding, cultivation, harvesting, marketing, animal industry, poultry breeding, and dairying. Attention is also given to the care of tools and their construction and use, also the use of incubators, brooders, and the latest and most improved dairy apparatus, such as separators, churns, and testers. Practice work in the making of butter and care and marketing of cream is a feature of dairy instruction.

For the girls a home garden department with instruction in the care of vegetables, fruits, and flowers has been provided. This is to show how home conditions can be improved and the usefulness of the home garden enhanced.

Agricultural instruction is given by the instructor in agriculture and animal industry and the foreman of the farm. The buildings of the academy include a class room, mechanics' building, and several dormitories and farm buildings. The farm consists of 128 acres, mostly under cultivation.

MISSISSIPPI.

Alcorn Agricultural and Mechanical College, Westside.

Students who can pass an examination in the fourth reader, elementary arithmetic to fractions, elementary geography, spelling and grammar, are admitted to a graded course in this institution covering three years and leading up to the college preparatory course. Lectures in agriculture are given throughout the first year of the graded course; text-book work, with Gulley's Agriculture, during the second year, and with McBryde's during the first term of the third year. The college preparatory course covers two years and includes a study of the First Principles of Agriculture, by Voorhees, during the second term of the junior year, and an industrial course throughout the senior year. The college scientific course of four years follows. In this course instruction in horticulture is given in the second term of the sophomore year; in feeding, with Armsby's text-book, during the first term of the senior year, and in the Physics of Agriculture (King) during the second and third terms of the senior year.

The text-book work is supplemented by lectures and practicums, the latter consisting chiefly of field work. The lectures include the composition of matter, origin and composition of soil for crops, rotation of crops, improvement of farm stock, insects injurious to farm and garden, breeds of live stock, etc. There are also special courses in agriculture including the following: Elements of agriculture, chemistry, botany, practical farming, agricultural chemistry, insects injurious to farm and garden, horticulture, practical farming, how crops grow, cattle feeding, and breeds of live stock. All of this instruction is given by the instructor in agriculture.

The college has a well-selected library of about 2,700 volumes, besides numerous pamphlets, magazines, weekly and daily papers. The buildings include 3 recitation buildings, 5 dormitory buildings, and a laboratory containing 6 rooms for the natural sciences, besides a number of dwellings for members of the faculty. The college owns 300 acres of land which is devoted to campus, garden, and pasture. The farm is stocked with 10 mules, a herd of Devon cattle, a number of hogs, and numerous agricultural implements. Most of the staple farm crops, fruits, and garden vegetables are produced.

MISSOURI.

Lincoln Institute, Jefferson City.

In this institution there is a four-year college course leading to the degree bachelor of arts. This is preceded by a three-year college preparatory course and a four-year normal course nearly parallel with the college preparatory course. There are also three-year industrial courses in carpentry, blacksmithing, machinery, sewing, and cooking. A subnormal course covering two years serves as a preparatory course for the normal, college preparatory, and industrial courses. Graduates in the normal course receive diplomas which entitle them to teach in any county of the State without examination.

Agriculture is required of all students in the subnormal, normal, and college preparatory departments. The theoretical instruction is given by the professor of science in the scientific department of the college, and farm practice is given under the direction of the farm manager. The buildings of the institution include a large, well-appointed main building, with class rooms, assembly hall, library, and laboratories; two dormitories, a mechanical building, a residence for the president, and a cottage on the farm for the manager. The farm consists of 25 acres, mostly under cultivation.

NORTH CAROLINA.

State Agricultural and Mechanical College for the Colored Race, Greensboro.

The North Carolina Agricultural and Mechanical College for the colored race offers two four-year courses of study, the agricultural leading to the degree of bachelor of agriculture, and the mechanical leading to the degree of bachelor of science. There are also industrial or trade courses and academic or college preparatory courses.

Candidates for admission to the college courses must be not less than 14 years of age, must understand fairly well the forms and rules of the English language, must be familiar with arithmetic, and have a knowledge of history.

In the college courses there is a total of 247 credits, of which 225 are necessary for graduation. A credit consists of one hour a week

of class-room recitation or two hours a week of industrial work for one term. The requirements for graduation in the agricultural course are as follows: Mathematics, 55; English, 35; geography, 10; wood-work, 3; drawing, 6; blacksmithing, 3; shoe and harness shop, 3; physics, 7; chemistry, 18; bookkeeping, 4; mechanics, 2; agriculture, 47; horticulture, 23; industrial, 26; and thesis, 5.

Candidates for diplomas are required to complete all the industrial courses. The courses offered by the agricultural department are described in the college catalogue as follows:

COURSES IN AGRICULTURE.

Course I. *Elementary principles of agriculture*.—Three credits. This term's work is designed to give the student a sort of bird's-eye view of the whole field of agriculture in an elementary way. It will be freely illustrated by experiment in the laboratory. It is required of all students to take this course, as it will aid them to choose intelligently between the agricultural or the mechanical course, which should be done at the end of the first year. Text: *Elementary Principles of Agriculture*.—McBryde.

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Course III. *Physical geography*.—Five credits. The course is illustrated by means of lantern slides and experiments. Text: *Tarr's Physical Geography*.

Course IV. *Breeding*.—Two credits. Such subjects as atavism, variation, selection, heredity, line breeding, and in-and-in breeding are discussed. Collateral reading required. Text: *Animal Breeding*.—Shaw.

Course V. *Dairying*.—Three credits. Lectures and recitation work. The composition, secretion, and production of milk is thoroughly discussed. Butter and cheese making are studied according to the latest and most improved methods. Text: *Milk and Its Products*.—Wing.

Course VI. *Bacteriology*.—Three credits. Lectures are given on the nature of bacteria, their relation to other plants, supplemented by laboratory work.

Course VII. *Agricultural bacteriology*.—Five credits. The relation of bacteria to the soil and the manure heap, to the ripening of cream and cheese, to various diseases, etc., is thoroughly discussed. Text: *Agricultural Bacteriology*.—Conn.

Course VIII. *Entomology*.—Three credits. The subject is taught by means of lectures and the student is required to read up on topics assigned him by the instructor. The most common insects and insecticides are studied.

Course IX. *Forage crops*.—Three credits. Lectures are given on the adaptability of the various crops that can be successfully and profitably grown in North Carolina to special soils, methods, and seeding; preparation of seed bed and pasturing are also discussed. Collateral reading required.

Course X. *Plant diseases*.—Three credits. Lectures and laboratory work. Common diseases, such as the cereal rusts and insects; diseases of cotton, tobacco, and fruit trees are studied with the aid of the compound microscope.

Course XI. *Feeding*.—Five credits. The laws of nutrition and the composition of animal bodies are briefly discussed. The composition and digestibility, market and food value of the various food stuffs are discussed. Nutritive ratios and the practical application of same in compounding ratios for the various farm animals are carefully considered. Collateral reading required. Text: *Feeding of Animals*.—Jordan.

Course XII. *Veterinary science*.—Three credits. The common diseases of farm animals are briefly discussed, together with remedies for same. Some practice work in caring for sick animals is also provided with the student. Text: *Veterinary Elements*.—Hopkins.

Course XIII. *Meteorology*.—Two credits. Movements of the atmosphere, character of winds, cyclones, tornadoes, thunderstorms, and weather forecasting are discussed.

COURSES IN HORTICULTURE.

Course I. *Botany*.—Two credits. The various parts of plants are studied. Lectures will be given twice per week.

Course II. *Botany*.—Five credits. Such subjects as how the plant takes up food from the soil and the atmosphere; the effect of sunlight, air, and moisture on plants are noted. Diseases of plants and remedies for same are discussed in an elementary way. Given in connection with Course I—Agriculture. Text: *Elementary Botany*.—Bailey.

Course III. *Propagation of plants*.—Three credits. Methods of propagating plants by cuttings, stallons, suckers, layering, seeds, etc., are discussed. The principles underlying budding, grafting, and pruning are also discussed. Text: *Principles of Plant Culture*.—Goff.

Course IV. *Small fruit culture*.—Two credits. Methods of propagating and cultivating various kinds of small fruit are discussed, together with the preparation of soil for same.

Course V. *Market gardening*.—Three credits. A study of the different crops adapted to market gardening and adapted to North Carolina is made. Construction and management of hotbeds, cold frames, special fertilizers for vegetable crops, packing, shipping, and marketing are also considered. Text: *Vegetable Gardening*.—Bailey.

Course VI. *Pomology*.—Two credits. Planting of fruit trees, tilling and fertilizing fruit lands. Planting and caring for orchards, picking, packing, storing, and shipping fruit are discussed. Text: *Fruit Growing*.—Bailey.

Course VII. *Plant breeding*.—Two credits. Methods of crops, fertilizing plants, originating new varieties, and how to improve old varieties are discussed.

Course VIII. *Landscape gardening*.—Two credits. Principles of embellishing landscapes, planting and management of woodlands, management of forests are discussed. Text: *Landscape Gardening*.—Maynard.

COURSES IN PHYSICS.

Course I. *Mechanics, hydraulics, hydrostatics, and pneumatics*. Three hours.

Course II. *Heat, magnetism, and electricity*. Two hours.

Course III. *Sound and light*. Two hours.

Course IV. *Agricultural physics*.—Five credits. The power of soils to retain moisture, effect of deep and shallow cultivation, methods of constructing farm buildings, ventilation, road making, draft of wagons and plows, etc., are fully discussed. Text: *Physics of Agriculture*.—King.

Course V. *Physical laboratory work* in mechanics of masses, liquids, gases, and heat. Three hours.

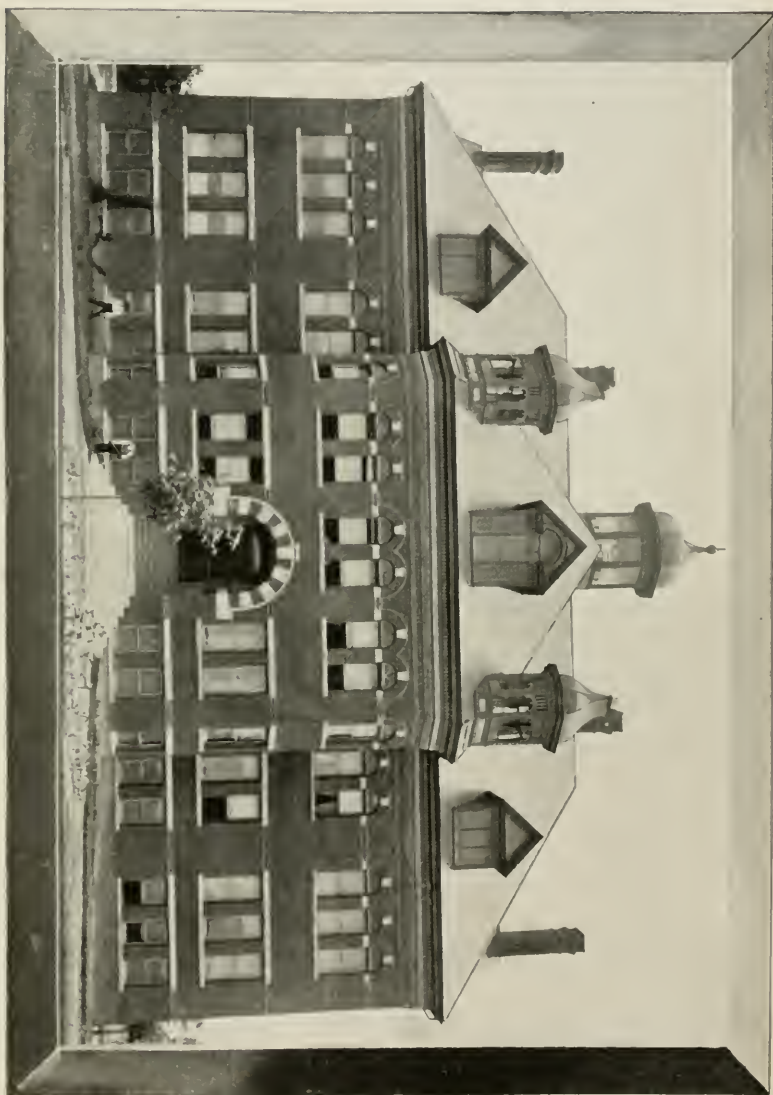
Course VI. *Agricultural physics laboratory work*.—Two hours. This course will accompany Course IV with detailed experiments to show the rate of percolation of water through soils; capillary attraction; effect of different kinds of mulches; determination of specific gravity and specific heat; and the mechanical analysis of soils. The department has been recently equipped with the latest apparatus for soil work.

COURSES IN CHEMISTRY.

Course I. *General chemistry lectures*.—Three credits.

Course II. *General chemistry lectures and laboratory work*. Three credits.

Course III. *Qualitative analysis. Laboratory work*. Three credits. During this term the student becomes familiar with testing for the metals and especially the 14 which enter into the composition of plant and animal life.



INSTRUCTION IN AGRICULTURE FOR NEGROES—NORTH CAROLINA AGRICULTURAL AND MECHANICAL COLLEGE FOR THE COLORED RACE, MAIN BUILDING.



FIG. 1.—GREENHOUSE WORK.



FIG. 2.—MAKING CUTTINGS.



FIG. 3.—BARN AND DAIRY.



FIG. 4.—GRAFTING AND POTTING
ROOM.



FIG. 5.—GREENHOUSE.

INSTRUCTION IN AGRICULTURE FOR NEGROES—NORTH CAROLINA AGRICULTURAL AND MECHANICAL COLLEGE FOR THE COLORED RACE.

Course IV. *Qualitative analysis.* Laboratory work. Two credits. Text: Appleton's *Qualitative Analysis*.

Course V. *Agricultural chemistry.*—Two credits. Lectures on the chemical composition of soils, plants, and animals. The function of the various elements necessary for plant growth and the various compounds for animal nutrition are discussed.

Course VI. *Quantitative analysis.*—Five credits. Instruction is given in the analysis of soils, fertilizers, and feeding stuffs, the object being to acquaint the student with the chemical composition of soils, fertilizers, and feeding stuffs, so that he may intelligently make use of reports and bulletins of experiment stations dealing with the chemical composition of various agricultural products.

Course VII. *Animal toxicology.*—Two credits. Lectures are given on the poisonous plants and insects injurious to stock; the symptoms of poisoning by paints, pigments, insecticides, matches, and vermin poison; the sources, elimination, and antidotes of stock poison, etc.

INDUSTRIAL COURSES.

(Two hours of practice work in Industrial Courses count one hour's credit.)

Course I. *Greenhouse management.*—Three credits. Practical work is given in the care and management of greenhouses. Students are required to grow and care for various flowers, such as carnations, roses, hyacinths, freesias, narcissus, etc., as well as various foliage plants, like ferns and palms.

Course II. *Propagation.*—Given alternately with Course III. Three credits. Practice is given in making cuttings, in potting, rooting, grafting, budding, etc. Each student is required to make at least 2,000 cuttings from 20 different kinds of plants and to root and pot same. He is also taught how to prepare various fungicides and insecticides, how and when to apply them.

Course III. *Gardening under glass.*—Two credits. Such plants as lettuce, beans, cucumbers, eggplant, tomatoes, etc., are grown under glass, and the student will be required to care for them and become thoroughly familiar with every detail of forcing plants for the winter and very early spring market.

Course IV. *Market gardening.*—Two credits. Practice is given in transplanting plants from the greenhouse or cold frames to the field. Attention is also given to raising early vegetables on a commercial scale.

Course V. *Care of live stock.*—Two credits. The student is required to go into the various barns of the college and obtain practice in feeding cows, horses, hogs, chickens, etc.; to learn various methods of feeding and make records of feeding experiments, to study the milk records and compare same with the various types of dairy cows.

Course VI. *Milk and cream testing.*—Two credits. The student is taught how to test milk and cream; he is made familiar with the Babcock test for fat; he is also expected to test milk for adulterants, determine its specific gravity, total solids, the amount of water it contains, and is required to make at least two tests of each cow in the college herd. He also becomes expert in testing cream for acidity according to at least two different methods.

Course VII. *Butter making.*—Two credits. Thorough drill is given in butter making according to the most improved methods. Considerable drill is also given in making neat and attractive packages, in sorting and scoring butter, ripening cream, etc.

Course VIII. *Management of dairy.*—Three credits. The student is expected to go into the dairy and take charge of the work under the supervision of an instructor. He receives instruction in the care and management of separators and obtains more practice in butter making. He is also expected to keep the dairy accounts and records.

Course IX. *Management of farm*.—Three credits. Practice is given in directing the work on the college farm under the supervision of the foreman of the farm.

Course X. *Poultry raising*.—Two credits. Practice is given in caring for poultry, in the management of incubators, brooders, etc.

Instruction is given by the professor of agriculture and chemistry, two assistants, and the director of industries. Most of the class recitations are in the main building (Pl. LVI). This is a large brick building with stone and terra-cotta trimmings, two stories high with basement. In the basement is the chemical laboratory, and on the first floor physical, chemical, and bacteriological laboratories and library. The remainder of the building is devoted to class rooms. The barn is a modern structure of wood and brick, the basement of which is used for dairy cattle and second floor for horses and farm implements. The dairy is a two-story brick and wood building, containing on the first floor a separating room and butter-making room and on the second floor a milk-testing laboratory, offices, and reading room. The dairy is well equipped with modern separators, churns, butter workers, refrigerators, Babcock tests, and other dairy apparatus.

There are also three greenhouses—one for the forcing of carnations, one for roses and other flowers, and one for early vegetables. The equipment for laboratory work in physics is modern in every respect and includes a ball-bearing balance, 50 cubic centimeter flasks for specific-gravity work, brass tubes for the determination of volume weight, apparent specific gravity and porosity of soils, apparatus to determine the power of loose and compact soils to retain moisture and the rate of percolation of water through soils, a set of galvanized-iron cylinders to show the effect of mulches or evaporation of water from soil, and a set of glass tubes for determining the capillary attraction of soils.

The farm of 125 acres is stocked with a fine herd of 35 pure-bred and grade Jersey cows and equipped with the most improved farm machinery and labor-saving devices. Corn, wheat, and potatoes are the most important crops, while other vegetables are grown to such extent as the market demands. A barn and 90-ton silo are the principal buildings on this farm. The college has purchased and received as donations from a number of firms a considerable amount of farm machinery, plows, harrows, cultivators, a seed drill, a corn harvester, and various tools and machines for market gardening.

OKLAHOMA.

Agricultural and Normal University, Langston.

This institution was established in 1897 and now has several substantial stone and brick buildings, including fairly well equipped shops, dormitories for boys and girls, and the president's house. The four-year courses offered by the university are the classical, scientific,

normal, mechanical engineering, and agricultural. There are also three-year college preparatory and architectural courses and four-year elementary courses. During the past year there have been no students in the collegiate courses.

The agricultural course as outlined in the catalogue of the institution includes the study of soils, crops, manures, farm equipment, breeds of live stock, plans of farm building, and judging live stock during the first year; farm economy, farm motors, farm roads, milk analysis, foods and food adulteration during the second year; horticulture, soil analysis, stock breeding and feeding, farm dairying, and drainage during the junior year, and diseases of animals in the first term of the senior year. The other subjects in the course include mathematics, beginning with trigonometry, English beginning with rhetoric, mechanical drawing, shop work, botany, biology, chemistry, vegetable pathology, comparative anatomy and physiology, history, surgery and sanitation, psychology, human physiology, geology, moral philosophy, and political economy. Instruction in agriculture is given partly by lectures and partly by text-books by one instructor.

Students have access to a library of about 600 volumes, including a number of publications of this Department. The college farm comprises about 160 acres, 90 of which are available for cultivation and 40 for pasture. The only farm building is a barn of very limited capacity and equipment. There is a span of mules, one horse, and one cow, also a few farm implements and machines. About 50 students have been taking agriculture during the past year.

SOUTH CAROLINA.

Colored Normal, Industrial, Agricultural, and Mechanical College, Orangeburg.

This institution admits children of kindergarten grade to the school and provides instruction that will carry them through college courses leading to degrees. The degrees given are bachelor of arts for the regular college course, bachelor of agriculture for the agricultural course, bachelor of science for the mechanical course, and licentiate of instruction for the normal course. Students entering any of the college courses are required to pass examinations or present equivalents in English grammar, history, composition, geography, arithmetic, algebra through quadratic equations, elementary physics, botany, and physiology.

Freshmen in the agricultural course have four hours a week of plane geometry throughout the year; two hours a week of Genung's Outlines of Rhetoric; two hours a week for one term of English classics; four hours a week of agriculture; five hours a week of farm work, and eight hours a week of industries. Sophomores have solid geometry,

four hours; rhetoric, two hours; history of civilization, two hours; English literature, two hours; chemistry, four hours; agriculture, four hours; farm work, five hours; and industries, eight hours. The subjects and hours for the junior class are: English literature, 2; agriculture, 4; botany, 3; physics, 3; chemical laboratory, 4; military science, 2; farm and dairy work, 2; and industries, 8. For the senior class the subjects and hours are: English literature, 2; chemistry, 4; geology, 3; agriculture, 4; physiology, 2; horticulture, 3; military science, 1; farm and dairy work, 5; and industries, 8.

Instruction in agriculture is given by the president of the college, who is also professor of agriculture, by means of lectures, recitations, and practicums. The nature and extent of the work is indicated in the following description of courses from the catalogue of the institution for 1902-3:

The soil.—A study of the origin, formation, and classification of the soils with reference to their agricultural value; the conditions of fertility and the circumstances that influence it; indications of fertility, barren, and exhausted soils; improvement of soils, physical properties of soils, including their relations to air, water, and heat; capillarity, diffusion, and solution, as related to soil texture; farm drainage, including methods of construction; irrigation, tillage, plowing, subsoiling, harrowing, etc.

Principles of manure and manuring.—Constituents of plants, sources and specific action of the various elements of plant food; crops and materials used as fertilizers; methods of farming in relation to the conservation of fertility.

Farm crops.—Plant breeding; variation, selection, self and cross fertilization; practical methods of increasing the yield of crops; conditions of germination and plant growth, rotation of crops; planting, growing, harvesting, and storing crops.

Animal husbandry.—This work begins with a careful study of the types of domestic animals. The score card is the basis in judging beef and dairy cattle, draft and light horses, swine, and poultry. After the student has become familiar with the most approved types, he studies the principles and methods of successful breeding, heredity, atavism, variation, selection, fecundity, etc.

Agricultural engineering.—Construction of barns, stables, and other shelters, fences, etc. Road building is considered with special reference to country roads. Some attention is given to the mechanics of farm implements and machines.

Stock feeding.—The laws of animal nutrition; composition of the animal body; fodders, the source of nutrients; digestion, resorption, circulation, respiration, and excretion; formation of muscle, flesh, and fat; composition and digestibility as determining the value of feeding stuffs, their preparation and use; feeding for fat, for milk, for work, and for growth. A portion of the time is devoted to practicums, in which the student is required to compound rations and feed them, carefully recording the results.

Dairying.—Breeding and improvement of the herd; management and equipment of the farm dairy. One half of the student's time is devoted to practical work in the college dairy, which is fully equipped.

Experiments in agriculture.—The work consists of lectures on methods of experiment-station work and critical studies of bulletins. The student is required to make abstracts of a sufficient number of bulletins bearing on a selected line of work, to become familiar with their scope and aim. He is also required to plan and conduct an original experiment, using the results obtained as the basis for a thesis.

Entomology.—Classification of insects sufficient to enable the student to distinguish between useful and injurious insects and to apply remedies intelligently.

Agricultural chemistry.—Soil, its formation, composition, alteration by mechanical, chemical, biological agencies; its relation to light, heat, and moisture. Soil physics in general. Manures, natural and artificial; their composition, application, value. Theory of rotation of crops; extensive and intensive cultivation; industrial agriculture in general. Farm sanitation; air, respiration, vitiated air and ventilation, infection, contagion, germ theory of disease. Water, potable water, hard and soft; impurities in it and their effects on health and life. Food, composition and general properties; preservation of food and food adulterations.

Butter making.—The running of separators; ripening and churning of cream; the proper acidity of cream to secure best flavor; how to churn, wash, and salt butter so as to avoid specks and mottles; to secure good grain and best methods for preparing for market are some of the points which receive special attention. As all creamery men should be able to judge butter from a commercial standpoint, students are trained daily in the art of scoring butter by the score card.

In the spring term, during the months of April and May, a special study is made of the relation of bacteriology to the dairy, tracing the various changes that take place in milk and its products to the action of bacteria; the isolation and culture of bacteria found in milk and dairy products, microscopic examination of milk, and a study of the influences of the size of globules on the creaming of milk and churning of cream. During the month there will be practice work in the creaming of milk, ripening of cream, churning and packing butter, and the making of cheese adapted especially for domestic manufacture and home use.

The industrial features of the agricultural course include practical farming, dairying, and cheese making, and are under the control of the superintendent of the farm. The college is well provided with large, substantial, and well-equipped buildings for class rooms, laboratories, and dormitories, besides industrial buildings in which the various trade courses are taken. The farm, consisting of 130 acres, is adjacent to the campus.

TEXAS.

Prairieview State Normal and Industrial College, Prairieview.

This college is a branch of the Agricultural and Mechanical College of Texas, located at College Station. It offers a normal course covering four years, and a collegiate course covering two years additional to the normal course. Candidates for admission to the normal course are required to pass an examination or present equivalents in arithmetic as far as percentage, orthography, English grammar and composition, geography, Texas history, and history of the United States. The minimum age limit is 16 years. Graduates of the normal course receive a teacher's diploma, and those of the college course the degree bachelor of arts or bachelor of science. A diploma from the college is equivalent to a permanent State teacher's certificate.

During the four years of the normal course agriculture is taught under the head of "Industrial theory and practice," which is made a part of each term's work throughout the six years of the two courses. It is described in the catalogue of the institution as follows:

COURSE IN AGRICULTURE.

FIRST YEAR.

First term.—Structure and classification of soil. Care of stock. Composting.

Second term.—Preparation of soil. Use of implements. Pruning, grafting, and cutting.

Third term.—Cultivation and habits of plants. Lectures.

SECOND YEAR.

First term.—Stock judging. Harvesting. Drainage.

Second term.—Selection, manner, and time of planting seed. Animal physiology.

Third term.—Animal physiology.

THIRD YEAR.

First term.—Arboriculture. Subsoil. Taproot.

Second term.—Veterinary science (text-book). Orchards and small fruits.

Third term.—Economic entomology. Lectures.

FOURTH YEAR.

First term.—Dairying. Cutting and rooting.

Second term.—Horticulture (market gardening). Hotbed forcing. Root crops.

Third term.—Farm management and business. Vegetable physiology.

JUNIOR YEAR.

First term.—Vegetable physiology. Agricultural chemistry.

SENIOR YEAR.

First term.—Agricultural botany. Road making.

The college provides a special course in dairy husbandry (feeding of dairy stock, feeding for milk) use of separator, and also conducts a class in butchering.

Instruction in agriculture is given by the professor of agriculture, the foreman of the farm, and a student assistant. Instruction is by means of lectures, text-books, and laboratory and field work. The text-books used are Lupton's Agriculture and Morrow and Hunt's Soils and Crops. Students have access to a reference library containing a number of carefully selected volumes and to current magazines and other reading matter. Among the agricultural works are the bulletins of the different experiment stations in the United States and a number of the best agricultural papers.

The principal buildings are the Academic Hall, containing offices, laboratory, library and reading room, chapel, and recitation rooms; the shop, a one-story structure, containing the woodworking and blacksmithing shops; a steam laundry, power plant, etc., and five or six dormitories. The college farm comprises 1,500 acres, upon which grain, cotton, hay, forage crops, and live stock are the principal assets. Pure-bred and graded cattle and hogs are kept for purposes

of instruction and practice in farm operations. There is also a good outfit of farm implements, including reaper, corn and cotton planters, and a variety of plows, harrows, and cultivators.

VIRGINIA.

Hampton Normal and Agricultural Institute, *Hampton.*

This institution was opened to negro children in 1868 and to Indian children in 1878. The courses of study offered include a three-year academic course followed by two-year normal, agricultural, business, domestic art, and domestic science courses. There are also numerous trade courses and summer normal courses. A practice school, admitting children from the kindergarten up, is connected with the institute.

For admission to the academic department applicants must be able to read well in books corresponding to the third reader, to write in a fair hand a paragraph or simple letter in English, and to pass satisfactory examinations both in mental and written work in the first four rules of arithmetic, in United States money, liquid, dry, and long measure, avoirdupois weight, and common and decimal fractions. Applicants for admission to the more advanced courses must be graduates of the academic course or must pass examinations equivalent to that course.

The equipment of the institute includes 60 buildings, several hundred acres of land, and all the necessary apparatus, machinery, live stock, etc. A description of the agricultural features of the instruction and equipment is given in the following article, prepared at our request by the officer in charge of the agricultural department of the institute:

METHODS AND FACILITIES FOR INSTRUCTION IN AGRICULTURE AT THE HAMPTON NORMAL AND AGRICULTURAL INSTITUTE.

By C. L. GOODRICH,

Professor of Agriculture, in Charge of the Agricultural Department.

The Hampton Normal and Agricultural Institute is a land-grant institution. Hampton differs, however, from the majority of land-grant colleges in that her pupils are negroes and Indians. It is an industrial school and its course of instruction is not carried to so high an academic degree as in other land-grant institutions.

The academic course covers the ground from the kindergarten through about two years of high-school work, barring all languages but English. The work from the kindergarten through the fifth grade is carried on in the Whittier School. This is the practice school of the institute and is attended by about 400 children from the immediate vicinity. The institute proper is attended by about 700 boarding students, girls and boys, from all parts of the South. Hampton offers

to students attending the institute proper an academic course covering three years, fourteen trade courses, and several post-graduate courses. The academic students attend school during the day, while the trade students attend night school for their academic training.

The following schedule of subjects and time periods in each week will give a somewhat definite idea of the course and the relative amount of time given to agriculture:

Junior year.	Periods.	Middle year.	Periods.	Senior year.	Periods.
English	8	English	8	English	8
Arithmetic	4	Arithmetic	4	Geometry	3
				Bookkeeping	2
Geography	4	Geography	4	History	3
		History	4	Civics	3
		News	2	Methods and psychology	4
Music	2	Music	1	Music	2½
Drawing	2	Drawing	2	Drawing	1½
Physiology	2				
Physics	2			Physics	1½
Manual training	4	Manual training	4	Manual training	4
Agriculture	3	Agriculture	2	Agriculture	2

The academic term is thirty weeks; a recitation period is forty minutes.

From this it will be seen that each pupil, trade as well as academic, is required to take some instruction in agriculture. This instruction in agriculture reaches down into the Whittier School, each child there receiving instruction in the subject two periods of thirty minutes each per week.

In addition to this required agriculture, the institute offers a three-year post-graduate course, also special elective courses of one year in several branches of the subject.

Hampton requires all of her pupils to study agriculture, not because she expects or desires that they all become farmers, but because (1) she knows that the great majority of the negro race in this country are located on the soil; (2) she believes that rural life in the South is the most desirable for the masses of the race; (3) she realizes that the present rural life of the negro is not what it should be; (4) she knows that the majority of her pupils come from the rural districts and it is her desire that they return to their people prepared to teach and help them to live better, economically, as well as socially and morally; (5) she knows that the majority of her pupils do go back to their people and that a great majority of them, whether they go as farmers, teachers, mechanics, or professional men and women obtain part of their subsistence directly from the soil; (6) she believes that the public-school teacher can be a most powerful factor in the future uplift of the agriculture of the country, by teaching the children the elementary principles which underlie successful farming.

The headquarters of Hampton's agricultural department are located



FIG. 1.—INSTRUCTION IN AGRICULTURE FOR NEGROES—HAMPTON INSTITUTE, DOMESTIC SCIENCE AND AGRICULTURE BUILDING.



FIG. 2.—INSTRUCTION IN AGRICULTURE FOR NEGROES—HAMPTON INSTITUTE, A CORNER IN THE GIRLS' GARDEN.



FIG. 1.—INSTRUCTION IN AGRICULTURE FOR NEGROES—HAMPTON INSTITUTE, MIXING FERTILIZERS.



FIG. 2.—INSTRUCTION IN AGRICULTURE FOR NEGROES—HAMPTON INSTITUTE, THE DAIRY.

in six large rooms in the Domestic Science Building (Pl. LVIII, fig. 1), which is located near the center of a 45-acre campus surrounded by the other buildings of the institute. These rooms are:

The museum and lecture room for chemistry and animal industry, the chemical laboratory, the horticultural laboratory, the farm implement room, the farm laboratory, the dairy. These rooms are finished with brick walls painted cream color and hard-pine ceiling varnished. They are lighted by electricity and are heated by steam.

The museum and lecture room for chemistry and animal industry is 31 by 55 feet. At one end of the room is a lecture desk, fitted with water tanks, gas, drawers, and cupboards, a chart case, chairs with writing arms for the accommodation of classes of from 30 to 50 pupils. On the walls are 42 linear feet of 43-inch slate blackboard. The other end of the room is furnished with six large museum cases in which there is a growing collection of illustrative material for use in class work, such as plants, rocks, soils, fertilizers, insects, etc. A beginning has been made toward an economic and industrial collection of farm products, illustrating the steps in the preparation of the raw material for use, the finished product, and the by-products. This room is also equipped with photographs and cuts of fine stock and a set of charts illustrating composition of feeding stuffs and fertilizers, the nutritive ratios of different foods, etc.

This room opens into the chemical laboratory, a room 31 by 45 feet, furnished with the usual chemical work tables, equipped with drawers, cupboards, bottle racks, water and gas, to accommodate 30 pupils. The room has two vapor hoods and a balance case, apparatus and chemicals sufficient to carry classes through qualitative analysis and to give them simple quantitative work. One end of the room is furnished with hand and steam turbine and Babcock milk testers.

The horticultural laboratory is 31 by 45 feet. It is used for general plant, soil, and entomological work. It has six laboratory tables, 42 by 60 inches, and four 30 by 50 inches. These are arranged on two sides of the room near the windows. They are furnished with drawers and stools with adjustable tops. The center of the room is furnished with chairs to accommodate 30 to 40 pupils. At the back of the room is a 16-foot cabinet for apparatus and illustrative specimens. The room is also furnished with book cases to accommodate a fairly full collection of the experiment station bulletins, bulletins of the National Department of Agriculture, and a collection of agricultural reference books. Connected with this room on the southwest side is a small conservatory, 8 by 30 feet, furnished with iron and tile bench, work table, sink, and insect cages. There is also connected with this laboratory a seed and apparatus room, 9 by 12 feet. This laboratory has an outfit of six Bausch & Lomb compound microscopes, furnished with double nose pieces, 1 and 2-inch

eye pieces, $\frac{2}{3}$, $\frac{1}{4}$, and $\frac{1}{8}$ objectives, a good microtome, water baths, reagents, stains, etc., for biological work. Aside from these the apparatus consists of bottles, glass tumblers, plates, tin pans, panes of glass, flower pots, lamp chimneys, fruit jars, boxes, simple balances, etc. One aim of the school is to make teaching as simple as possible, hence the use of simple apparatus in order to avoid confusion on the part of the pupils and to acquaint them with such simple material and apparatus as can be obtained almost anywhere they may happen to be teaching.

The farm-implement room is furnished with a fair collection of modern farm tools and machines, consisting of plows, harrows, cultivators, planters, mowers, harvesters, seed cleaners, draining tools, spray pumps, etc.

The farm laboratory has no special outfit of apparatus. (Pl. LIX, fig. 1.) It is used for general work, such as preparing soils for laboratory work, preparing vegetables for market, repairing implements, observation lessons in animal industry, and for storing crates, implements, etc.

The dairy is a room 31 by 55 feet. (Pl. LIX, fig. 2.) It is equipped with apparatus for illustrative and practical work in the different methods of caring for milk and converting it into butter and cheese, namely, shallow pans, Cooley creamer, three separators, aerators, cream vats, churns, butter bowls and patent butter workers, cheese vats, cheese press, hot and cold water, and steam for sterilizing.

In addition to the above-mentioned rooms in the domestic-science building the institute has two plant houses, covering an area of 3,000 square feet, and several hundred sash for cold-frame and hotbed work; also a farm barn, 50 by 100 feet, with an "L" 40 by 100 feet. This houses 25 horses and 45 grade dairy cows, and has milk room, harness rooms, and storage for grain, hay, bedding, carts, and tools. Connected with it are two square brick silos.

For practical work in poultry raising the institute has a poultry house that accommodates 240 fowls, representing eight breeds, with several smaller houses for common fowl and chickens, an incubator house, and a brooder house.

Adjoining the 45-acre campus are 90 acres of land under cultivation. This land is disposed as follows:

Two acres are used for a county-school garden; 8 acres are used for simple experiments, illustrative and practical work with crops and fertilizers; 12 acres are in fruit. The remainder is used for growing truck, grain, and forage crops.

Five miles from the campus is a second farm of about 600 acres, of which 400 acres are under cultivation. This farm is conducted as a dairy farm.

The country-school garden is divided into three sections. Section 1 is being developed into a small park; section 2 is divided into individual

garden beds, varying in size from 4 by 6 to 11 by 15 feet, used for growing vegetables and flowers; section 3 is used for farm crops.

The fruit garden is divided as follows: Grapes, one-half acre; raspberries and blackberries, $1\frac{1}{4}$ acres; pears, $1\frac{1}{4}$ acres; apricots, nectarines, and persimmons, 1 acre; apples, $2\frac{1}{2}$ acres; miscellaneous, three-fourths acre.

The remainder of the farm is cut by ditches and convenient roads into fields of from 5 to 16 acres.

The soil of the farm varies from a clay loam to a sandy loam and is in a very good state of fertility, to which it has been brought by deep and thorough tillage and the free use of farm manure. The principal crops grown on the farm are white potatoes and garden peas for shipping; corn for grain, soiling, and silage; small grain for feeding; grass, clover, alfalfa, and cowpeas for soiling, hay, and soil improvement; garden vegetables for home consumption.

In general the method of cultivation is deep and thorough soil preparation, with flat and shallow after cultivation. Fertilizing is done mainly with stable manures and green crops turned under, with the addition of bone meal, acid phosphate, potash salts, and cottonseed meal.

The work of the institute is largely done by the students. An average of 15 to 20 students are employed all the year on the farm. These students work all day and attend night school. A large number of day-school students spend one day of each week at work on the farm. During the past summer 56 students spent the vacation working on the farm.

Elementary agriculture, as stated above, is a part of the prescribed course of the Whittier School, and is required of every pupil who enters the institute. Many of these pupils, particularly the older ones, come from farming communities. Their experience with agriculture has been discouraging and they have developed more or less prejudice against it. Others, coming from the cities, look upon farming with more or less disfavor. For this reason the institute finds it necessary to use some judgment in approaching the pupils with the subject. With this in view the school is divided into two large sections. The first section consists of the younger children, or those of the kindergarten and first four grades, together with postgraduates and special students, who elect some branch of agriculture. These students begin the study by actual work in the garden, field, or stable. The second section, or those of the sixth grade and up, a large number of whom enter the school at this grade, are approached through simple nature and science lessons having a bearing on agriculture, with the idea of developing in the student an interest in the subject without increasing the prejudice.

The course in agriculture, then, begins in the kindergarten class.

These children and all up through the fifth grade attend our Whittier School, and do their first work in agriculture in the school garden. A section of this garden, as indicated above, is cut up into small beds, varying in size from 4 by 6 feet for the kindergarten to 11 by 15 feet for the fourth and fifth grades. Two children are assigned to each bed and they care for the bed together. The aim in the garden is to make the work a pleasure to the children and not let them see the harder side of it until they have developed a liking for it. This work begins at the opening of school in October, at which time the gardens are thoroughly spaded, raked, and planted with such crops as spinach, kale, radishes, and onions, which generally stand the winter climate of the region very well, and give the children a crop of radishes before Thanksgiving and early spring crops of the other vegetables. These crops are followed by summer vegetables and flowers, the children being allowed to take home what they raise. At the close of the school, the last of May, volunteers are called for to carry on the summer work. About one-quarter of the school has volunteered each summer thus far. There would have been many more volunteers, but the children come from poor families and many have to work for wages during the summer.

The children come to the garden by classes and class sections of thirty to fifty, each class working two half-hours a week. Some of the lessons taught are as follows: How to use the spade, hoe, rake, dibber; how to prepare the soil for planting; how to plant seeds; how to transplant; how to care for the garden after it is planted; how to propagate and care for small fruits.

During the winter the garden work is supplemented by window gardening and simple nature lessons with plants and soils. Each pupil has a window box 9 by 18 inches by 3 inches deep. In these boxes plants are propagated by seeds and cuttings to be transplanted to the garden in the spring. In this way the garden is supplied with early cabbages, lettuce, tomatoes, and flowering plants.

The nature lessons center largely in the garden and are based on the work done there. The object of the work is to arouse an interest in plants and animals, and to teach simple facts and principles which will be useful in the garden and on the farm. The Whittier School enrolled last year 432 pupils, all of whom worked in the garden. This garden and nature work is in charge of one of the instructors of agriculture assisted by the class teacher, normal students, and special agriculture students.

Work in agriculture for the second large section of pupils begins with the junior academic class which corresponds to about the sixth grade. These are the pupils who come with more or less prejudice against farming and are approached in the subject through simple science and nature work. During the junior year, an aggregate of five months,



FIG. 1.—INSTRUCTION IN AGRICULTURE FOR NEGROES—HAMPTON INSTITUTE, SWEET POTATO ROOTS.



FIG. 2.—INSTRUCTION IN AGRICULTURE FOR NEGROES—HAMPTON INSTITUTE, JUDGING DAIRY STOCK.

fall and spring, are devoted to introducing the pupils to plant life, soil, and insect life. The object of the work is to arouse an interest in nature and to teach in a simple way some of the fundamental truths of agriculture. A brief outline of the work is as follows:

Plant Life.—Principal parts of plant and the use of these parts to man; how these parts grow and what they do for the plant; conditions necessary for each part to make its best growth and to do its best work for the plant and for man; how to bring about these conditions.

Soils.—Relation of soils to plants; sand, clay, humus; how soils are made; work of sun, water, ice, air, plants, and earthworms in making soils; soil conditions which affect plant growth; relation of soil to water, heat, and air; plant food in the soil; how to bring about and maintain soil conditions which favor plant growth.

Insect Life.—General structure, metamorphosis, and habits are studied in grasshoppers, squash bugs, beetles, flies, bees, moths, and butterflies; the habits of other insects common on the farm are studied as they are found during field excursions.

The divisions of the subject are not taught as separate and distinct topics, an attempt being made to impress the student with the close relation existing between them and the interdependence of each on the other.

The method of instruction is by observation and experiment in field and class room, by written exercise, and by discussion. The lecture method is eliminated as far as possible. Each pupil takes part in every field excursion and observation lesson and performs or assists in performing nearly every class-room experiment. The interest of the pupil is more easily aroused and held by putting him actively in touch with the work. Hampton has a great deal to do for her pupils during the limited time that they are with her; therefore she finds it necessary to eliminate an amount of matter that is usually taught in the schools and to select mainly those things that will be of practical value to the student during the life for which she is fitting him. For this reason the attempt is made to make every lesson in agriculture, and particularly in the first year, teach some fundamental principle or practical truth. For instance, in studying roots the pupils are taken to the field to observe the roots of several plants which have been exposed as in the accompanying illustration of sweet potato roots (Pl. LX, fig. 1). Arrived in the field the class is asked the following questions:

In what part of the soil do you find most of the roots?

How near the surface of the soil do you find roots?

How far do you find them reaching out sideways or laterally from the plant?

How deep do you find them penetrating the soil?

These questions are generally answered. Then follows the question:

Of what value is it to the farmer or plant grower to know about

these things? The discussion brought out by this last question develops important facts relative to soil preparation, after-cultivation, distribution of manure and fertilizers, and soil drainage. The usual questions: Are they fibrous roots or fleshy roots? clustered roots or tap root? etc., are considered of but secondary value and, unless the time permits, are eliminated. In studying leaves, emphasis is placed not on form, but on functions and conditions which favor or interfere with the functions and value of these facts to the plant grower.

The work of the second or middle academic year is based directly on the principles taught during the junior year. The subjects studied are soil water, farm drainage, after-cultivation, rotation of crops, plant propagation, injurious insects and plant diseases, manures and manuring. Practical work begins this year and by this time the pupils generally take kindly to it.

The subjects for the senior year are care and management of farm stock; dairying including care and testing of milk, methods of creaming, ripening, churning, etc.; elementary principles of stock breeding, and stock feeding. The student is made familiar with the different types and breeds by bringing the animals into the class room and taking the class into the stables and poultry houses. The latter method also affords an opportunity for observing the construction of farm buildings and the general management of live stock (Pl. LX, fig. 2).

This required agriculture is given to both girls and boys. No textbooks are used. In the junior year Bailey's Principles of Agriculture is put into their hands as a reference book. In the middle and senior years they are given outline leaflets and United States Farmers' Bulletins and referred to the general reference library.

The post-graduate course of three years follows the same general outline as the required course, but covers a wider field. It carries the student into simple quantitative analysis in chemistry. Bailey's Botany and Gray's Manual are used in plant study, with references to Bailey's Lessons with Plants and Coulter's Plant Relations. The Soil, by King; Fertility of the Land, by Roberts; Voorhees's Fertilizers; Milk and Its Products, by Wing; Feeds and Feeding, by Henry; Curtis's Horses, Cattle, Sheep, and Swine; The Principles of Fruit Growing, The Pruning Book, and The Nursery Book, by Bailey; Farmers' Bulletins, and bulletins from the State experiment stations are used as text and special reference books. The general reference library is close at hand and is constantly used.

The members of this class spend two or three hours each day in class and laboratory work in the field, stable, dairy, or poultry house, or act as assistants in the laboratory work of the lower classes.

The work of all the classes is largely done through field excursions for observation, actual field work, and laboratory work. Few textbooks are used and in some of the classes none. No attempt is made

to cover a large amount of ground. The aim is to fix thoroughly in the mind of the pupil a few of the more important and fundamental facts and principles and to start him thinking and investigating for himself. Not as much time, perhaps, is spent in reviews and examinations as is customary in some institutions, and yet the pupils are being reviewed and examined all the time. An effort is made to base each new step or each new subject upon what has gone before, so that previous work is constantly referred to and kept fresh in the mind, and unless each step is well done the advance step is more or less a failure. With the Whittier and academic classes the agriculture is used largely as a basis for work in English and somewhat for arithmetic. So, while teaching the latter two subjects the teacher at the same time gets a gauge of the work in agriculture.

The force of agriculture teachers the past year consisted of (1) 6 lady teachers, giving part time to the teaching of elementary agriculture; (2) 1 male instructor, devoting his time to chemistry and animal industry; (3) 4 male instructors, giving their full time to general agriculture and horticulture.

The number of students that received instruction in agriculture last year was as follows:

	Girls.	Boys.	Total.
Whittier School	260	172	432
Junior class	95	107	202
Middle class	65	139	204
Senior class	24	40	64
Post-graduates	2	3	5
Specials		4	4
	446	465	911

The agricultural reference library, which is located in the horticultural laboratory, contains about 100 standard works on agriculture, horticulture, and the sciences relating to these subjects, and about a dozen of the leading agricultural periodicals.

WEST VIRGINIA.

The West Virginia Colored Institute, *Institute*.

This institution is located eight miles west of Charleston, on the Great Kanawha River. It offers a preparatory course of one year, leading to a four-year secondary normal and agricultural course. There are also commercial and industrial courses, covering from one to four years. The requirements for admission to the preparatory course are an age limit of 14 years, ability "to read well in the Fifth Reader," and a "knowledge of compound numbers and of fractions." Graduates of the industrial courses receive certificates and of the normal course diplomas.

During the first term of the agricultural course instruction is given in general agriculture, including the origin and classification of the physical and chemical properties of soils, the relation of air and water to soils, composition and primary objects of plants, farm work, etc. During the second term breeds of live stock are studied; the third term, horticulture, and entomology. The agricultural subjects of the second year are farm practice, stock breeding, and vegetable histology; of the third year, soils and fertilizers, landscape gardening and farm work, stock feeding, market gardening, and dairying; of the fourth year, agricultural chemistry, dairy bacteriology, farm work, veterinary science, plant diseases, and fruit growing. Poultry raising is also made a feature of the agricultural course. Along with the agricultural subjects students study arithmetic, algebra, geometry, physiology, English (including rhetoric and English literature), United States and general history, civics, zoology, physics, chemistry, botany, physical geography, and economics. Instruction in agriculture is given by the professor of agriculture and botany.

The library of the institute consists of a well-chosen assortment of books, including encyclopedias, atlases, and other reference books, a number of Government publications, current periodicals, and newspapers. The library is located in West Hall, which also accommodates the agricultural department and the cooking department. There is also an academic building, a well-constructed brick building containing offices, recitation rooms, assembly room, sewing department, dairy, and printing office; dormitories for young men and young women, and a large building for the trades school. These buildings are located on grounds containing 31 acres.

Value of equipment of land-grant colleges and schools for colored persons in 1903.

State or Territory.	Farm and grounds.	Buildings.	Apparatus.	Machinery.	Library.	Live stock.	Miscellaneous equipment.	Total.
Alabama.....	\$18,200.00	\$45,353.54	\$4,001.58	\$4,992.30	\$2,957.00	\$400.00	\$532.09	\$76,436.51
Arkansas.....	50,000.00	26,000.00	500.00	12,000.00	3,000.00	.....	1,500.00	93,000.00
Delaware.....	6,000.00	18,800.00	1,000.00	8,000.00	.....	.....	.....	33,800.00
Florida.....	5,500.00	20,000.00	6,944.55	1,650.00	1,000.00	1,410.00	3,000.00	39,504.55
Georgia.....	10,000.00	32,433.04	3,144.00	.....	100.00	415.00	.....	46,092.04
Kentucky.....	22,600.00	23,000.00	400.00	2,500.00	1,800.00	.....	1,200.00	51,500.00
Louisiana.....	22,500.00	47,760.82	3,196.78	4,415.10	3,980.00	1,100.00	7,200.00	90,452.70
Maryland.....	6,000.00	16,000.00	1,400.00	1,300.00	400.00	1,250.00	2,000.00	28,350.00
Mississippi.....	6,000.00	150,000.00	10,000.00	.....	3,000.00	2,000.00	2,000.00	173,000.00
Missouri.....	6,000.00	100,000.00	400.00	5,000.00	300.00	150.00	50.00	111,900.00
North Carolina.....	18,000.00	60,000.00	1,000.00	6,000.00	1,150.00	972.50	.....	90,122.50
Oklahoma.....	5,000.00	33,904.35	1,500.00	8,569.25	1,600.00	525.00	2,044.25	53,142.85
South Carolina.....	40,000.00	8,500.00	3,600.00	7,150.00	1,700.00	2,200.00	2,000.00	65,150.00
Texas.....	15,000.00	92,100.00	1,000.00	3,000.00	909.00	2,600.00	.....	114,669.00
Virginia.....	57,000.00	591,000.00	.....	.....	6,500.00	14,000.00	\$155,000.00	823,500.00
West Virginia.....	12,000.00	74,000.00	.....	18,771.00	2,000.00	500.00	1,500.00	108,771.00
Total.....	299,800.00	1,338,851.75	41,386.91	83,347.65	30,396.00	27,582.50	178,026.34	1,999,391.15

^aIncluding apparatus and machinery.

Revenue of land-grant colleges and schools for colored persons in 1902-3.

State or Territory.	State aid.			Fees and all other sources.			Total income.
	Federal aid, act of 1890.	Appropriations for current expenses.	Appropriations for buildings or other special purposes.	Tuition fees.	Incidental fees.	Miscellaneous.	
Alabama.....	\$11,150.00	\$1,000.00	.....	.....	.....	.....	\$15,150.00
Arkansas.....	6,818.18	3,789.00	.....	\$329.00	.....	.....	10,936.18
Delaware.....	5,000.00	.....	.....	1,500.00	\$134.10	\$2,071.39	9,005.49
Florida.....	12,500.00	2,000.00	\$200.00	.....	.....	500.00	15,200.00
Georgia.....	8,333.33	8,000.00	.....	.....	200.00	.....	16,333.33
Kentucky.....	<i>a</i> 4,880.50	8,000.00	.....	.....	.....	2,257.76	15,338.26
Louisiana.....	12,318.77	10,000.00	.....	168.00	76.50	851.35	23,444.62
Maryland.....	7,411.82	.....	.....	103.50	415.00	1,361.53	9,291.85
Mississippi.....	<i>b</i> 26,026.27	8,000.00	3,000.00	.....	1,068.00	700.00	38,794.27
Missouri.....	1,562.50	22,175.00	10,000.00	.....	.....	.....	33,737.50
North Carolina..	8,250.00	7,500.00	5,000.00	.....	.....	22,938.78	43,688.78
Oklahoma.....	2,500.00	17,000.00	.....	.....	.....	.....	19,500.00
South Carolina..	<i>c</i> 18,254.00	.....	6,500.00	.....	.....	.....	24,754.00
Texas.....	6,250.00	20,500.00	.....	.....	.....	12,241.26	38,991.26
Virginia.....	<i>d</i> 69,269.57	.....	.....	.....	.....	124,777.39	194,046.96
West Virginia...	5,000.00	1,600.00	22,000.00	.....	116.00	809.95	29,525.95
Total.....	205,554.94	112,564.00	46,700.00	2,100.50	2,309.60	168,509.41	537,738.45

a Including \$1,255.50 interest on land grant of 1862.

b Including \$6,814.50 interest on land grant of 1862 and \$5,775.77 interest on proceeds of sale of college lands.

c Including \$5,754 interest on land grant of 1862.

d Including \$10,329.36 interest on land grant of 1862 and \$50,606.88 income from endowment other than Federal or State grants.

Students in the land-grant colleges and schools for colored persons in 1902-3.

State or Territory.	Preparatory.	College.	Short or special.	Post-graduate.	Other departments.	Total.	Students in agriculture.	Degrees conferred.	Number of graduates—	
									In 1902-3.	Total since organization.
Alabama.....	378	9	81	.....	.....	468	136	3	74	746
Arkansas.....	82	98	.....	.....	.....	180	.....	5	5	160
Delaware.....	34	19	2	.....	.....	55	2	2	4	22
Florida.....	167	.....	.....	.....	4	171	15	.....	14	49
Georgia.....	405	32	2	.....	.....	439	40	1	21	125
Kentucky.....	35	19	.....	2	114	200	29	.....	15	115
Louisiana.....	377	.....	325	.....	.....	377	46	.....	30	245
Maryland.....	140	.....	.....	.....	.....	140	56	.....	.....	9
Mississippi.....	479	55	.....	.....	.....	534	158	.....	7	140
Missouri.....	81	1	22	3	276	386	80	28	28	220
North Carolina..	.....	166	1	.....	.....	167	30	11	11	35
Oklahoma.....	237	.....	.....	.....	.....	237	53	.....	2	2
South Carolina..	601	64	.....	.....	.....	665	116	59	59	233
Texas.....	276	.....	.....	.....	.....	276	26	3	45	306
Virginia.....	888	269	<i>a</i> 455	23	.....	1,635	911	.....	84	1,236
West Virginia...	144	.....	6	.....	.....	150	12	.....	20	103
Total.....	4,327	732	894	28	424	6,080	1,680	119	422	3,746

a Including students in the summer school.

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