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(L'ASSOCIATION SCIENTIFIQUE INTERNATIONALE D'AGRONOMIE COLONIALE ET TROPICALE)

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# PREFACE.

THE volume of *Proceedings* of the Third International Congress of Tropical Agriculture (London: John Bale, Sons and Danielsson), which has been published separately, includes the President's Address, abstracts of the principal papers prepared by the authors, and full reports of the discussions which followed the reading of the papers submitted to the Congress. The present volume of *Transactions* contains the first instalment of the papers communicated to the Congress, the remainder of which will be published in a second volume. The difficulties of the present international situation, which arose a few weeks after the conclusion of the Congress in July, 1914, are chiefly responsible for the absence from these *Transactions* of a few papers communicated to the Congress.

The papers contributed by the Portuguese Section of the International Association for Tropical Agriculture are not included, as they have been printed separately (Imprimerie "A Editora Limitada," Largo do Conde Barão, 50, Lisbonne), and distributed to members of the Congress. The papers from Portugal relating to the subjects included in the present volume, which have already been issued, are as follows:—

"Rapport sur le Crédit agricole dans les Colonies portugaises." Par Henrique José Monteiro de Mendonça, José Dionisio C. de Sousa e Faro, et Ernesto Jardim de Vilhena.

"Contribution pour l'Etude des Cotons des Colonies portugaises." Par le Professeur C. de Mello Geraldes.

"Projet pour l'Etablissement d'une Méthode rationnelle pour la Détermination de la Valeur commerciale des Textiles." Par le Professeur C. de Mello Geraldes.

"Contribution pour l'Etude des Plantations de Caoutchoutières à Angola." Par le Professeur C. de Mello Geraldes.

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# TECHNICAL EDUCATION IN TROPICAL AGRICULTURE.

## TECHNICAL EDUCATION IN TROPICAL AGRICULTURE.

By Gerald C. Dudgeon, F.E.S.

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The rapid extension of plantations in the British tropical dependencies, exploited by capital subscribed to a large extent in the Mother Country, has rendered competition in the markets for the products of such plantations so keen that the most skilled supervision of the latter is now demanded. Carefully reasoned and scientific principles require to be substituted for the crude rule-of-thumb methods which have amply served their purpose in the past, but which are quite inadequate for ensuring success in the future.

Proprietors of tropical plantations from time to time seek for new candidates, to fill the subordinate posts of plantation assistants, who shall have acquired even an elementary knowledge of the subject with which they would have to deal; but instead, they are obliged to be satisfied with the engagement of young men who have obtained a diploma of agriculture at an English college or with those who have relinquished plantation work elsewhere. In the case of the former it often happens that after having been put to the trouble of training them the most promising among them are quickly appreciated by the owners of neighbouring plantations and they cannot be retained by their original trainers. In the case of the latter it is obvious that in many instances the result must be unsatisfactory, discards being chiefly made from weakness.

Although the larger number of men trained in tropical agriculture are required for plantation work, the necessity for others similarly qualified for employment in Government Agricultural Departments is becoming more acute each year. The value which is attached to the establishment of a Government Department of Agriculture is entirely commensurate with the position of authority upon agricultural subjects which its officers are enabled to take up. In the United States the Government were sufficiently far-sighted to recognize that the welfare of the country largely depended upon the adoption by agriculturists of the most perfected method of dealing with every agricultural problem. Agricultural colleges are found in every part of the country, and the instruction given them is of a practical as well as of a scientific nature, extending to sub-tropical, at least, as well as temperate zone requirements. Besides turning out a number of diplomaed graduates each year, the nation is in a position to select trained men with the highest attainments for employment in the Government Service. The United States Department of Agriculture is thereby in a position to give an authoritative reply to any inquiry respecting the treatment of crops, and is looked to to provide from time to time the best advice upon the subject.

Owing to the fact that our only training colleges in agriculture for English youths are situated in a temperate climate and that the curriculum is narrowed to the local requirements of such a climate, it is rare to find a Government official in the British Colonies and Dependencies who can advise with regard to tropical plantation work, or who can do more than point to the errors, due to prejudice, committed by an ignorant native population.

A few Departments have advanced sufficiently far to be able to give advice on questions of economic entomology, chemistry, or botanical science; but, although such is the case in India and Ceylon, I should be surprised to learn that there was any official in the employment of the Indian Government qualified to give advice to planters concerning the cultivation or preparation for the market of even the most important exported plantation product, namely, tea. This should not be the case, but must remain so until a more advanced and applicable system of instruction is established whereby students may become qualified in all branches of tropical plantation agriculture or be enabled to specialize in any.

Until about eight or nine years ago, the posts provided in the Agricultural Service of the British East and West African Colonies and Protectorates were filled from Kew, apparently upon the vague supposition that, as a Kew gardener was associated with the growing of tropical plants under artificial conditions, he was qualified to advise upon tropical agriculture. More recently graduates from the Universities or students with diplomas from the British Agricultural Colleges were sent to study under the Agricultural Department in Ceylon under a scheme initiated by the Director of the Imperial Institute in London. The benefits which accrued from the practical demonstration given to those sent to Ceylon emphasized the urgency of the establishment of a superior college of tropical agriculture.

The value of the British agricultural diploma must not be too lightly regarded; for, although it is based on studies conducted under temperate conditions, it must be remembered that these form an excellent basis for the student to work upon. The qualification for entry into a superior college of tropical agriculture in the tropics might include the possession of a diploma from Great Britain. The course in tropical agriculture must necessarily be of a more highly technical character than that required for the British diploma.

It is practically impossible that a satisfactory course of training can be given except in the tropics themselves, and it therefore becomes necessary to determine the best centre or centres for the establishment of the colleges.

The course in tropical agriculture should be so arranged that students may specialize in the study of plantation work adapted to the country in which they contemplate obtaining employment. It is also essential, as somewhat different conditions obtain, and special crops are cultivated in each country, that, wherever the college be situated, undue attention should not be given to the local needs. It has been suggested that two colleges shall be founded, one in the West and the other in the East Indies; but, although the course of training would be similar in each, the relative value of each branch of instruction must vary in accordance with the requirements of the zones to which each college is intended to contribute trained men.

The West Indian College should undertake the training for the whole of the West India Islands and British Guiana, for which there need hardly be any great diversity in the course; but the college having its centre in the East Indies would be obliged to deal with a much greater number of subjects. From the latter college students might be required to qualify in the special agricultural and plantation methods employed in India, Ceylon, Malay States, Borneo, East, Central, and West Africa, and the Sudan.

It has been suggested that Ceylon offers the most suitable site for the Eastern College, and there are, indeed, many advantages in support of this selection. It is assumed that, as every British Colony or Protectorate would stand to gain by the establishment of a superior tropical agricultural college, contributions towards the foundation of the same would be made by each Colony, supplemented by one from the Imperial Government. Associations and mercantile firms having interests in plantations in the tropics would also be expected to contribute. In the event of Ceylon being chosen in these circumstances as the site of the college, special care would have to be taken not to allow the teaching of subjects specially adapted to the requirements of students in training for posts in Ceylon itself to be laid down in the curriculum so as to exclude or supersede those which might be necessary for India or Africa.

In comparing the important plantation products from the countries which would be included in the Eastern College zone, it will be readily seen that there is considerable variation:—

CEYLON.—Tea, rubber, cinchona, coffee, cocoa, and copra.

Malay States.—Rubber, tapioca.

India.—Tea, coffee, cinchona, cotton, sugar, indigo, tobacco, and jute.

African Colonies.—Cotton, oil seeds, cocoa, coffee, rubber (of several kinds), kola.

In connection with the college there should be a demonstration plantation of a sufficiently large extent to enable a practical study being made of the habits and methods of cultivation employed with respect to all the above-named crops, but in order to obtain a diploma the student might only be required to qualify in tea, rubber, cocoa, and cotton, with another selected subject.

The chemical, entomological, and botanical sides of all the products dealt with should be made a compulsory part of the training for the diploma course, and facilities should be given for students to specialize in any of these subjects.

The preparation or manufacture of such of the products as require it should form part of the instruction, and the working of the necessary machines should be demonstrated. The different modes of cultivation or preparation of the same product in different countries is a point of importance; the cultivation of tea, for example, varies considerably in Assam, Darjeeling, Punjab, and Ceylon.

Accepting the fact that the majority of students in the tropical college would be candidates for posts upon rubber, tea, cotton, cocoa, or coffee plantations, where a large number of labourers are retained for the working of the estate, it is necessary to consider what subjects, in addition to those directly associated with the cultivation, scientific treatment, and preparation of these plantation products, are useful, if not essential, to obtain the best results. Among these, surveying, building construction, the erection of machinery, sanitary arrangement of labourers' dwellings, uses of simple medicines, first treatment of epidemics, and book-keeping are of importance.

In the few agricultural schools in existence, as, for instance, those in South Africa, some of the sub-tropical plantation products are studied in the school course, and demonstration farms are employed to assist in the instruction given. In India, also, students in agricultural chemistry and entomology are trained at Pusa. Nevertheless, there is at present no systematic instruction in agriculture obtainable which is capable of producing scientifically trained men for employment upon the more important plantations of the tropics or for Government service in the tropical Colonies and Dependencies.

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## ON AGRICULTURAL EDUCATION AND ITS ADJUSTMENT TO THE NEEDS OF STUDENTS.

By Francis Watts, C.M.G., D.Sc., F.I.C.

*Commissioner of Agriculture for the West Indies.*

The very varied aspects and the great range of subjects embraced by the designation "agricultural education" make it difficult to formulate clear views on the subject and tend to some confusion of ideas, nor are the difficulties lessened if consideration is given to the tropical aspects of agricultural education. In the latter case attention has to be given to a range of conditions, of crops, and of climates that may become bewildering.

In much that has been said concerning agricultural education, want of precision has resulted from omission to consider carefully what class of pupil is to be trained under each particular scheme and what he is to be trained for; it may, therefore, be worth while to endeavour to obtain a clear idea of the status of certain pupils and their requirements. In what follows regard is mainly given to agriculture in its tropical aspects, and chiefly as exemplified in certain West Indian Colonies.

Beginning with the most elementary grades, consideration may be given to the scholars in elementary schools. Both the critics and the well-wishers of this class are often unduly disposed to urge an extremely utilitarian method of training for these pupils, having in view, perhaps unconsciously, something in the nature of a technical school, and looking for results such as may be expected from technical training. Obviously, this seems unfair alike to teacher and scholar; all that can be expected at this stage is an elementary familiarity with the most striking facts of agricultural life in such phases as will be presented to these elementary scholars when they leave school. They may well be taught elementary facts about plant and animal life, about the manner in which seeds germinate and plants grow, and the fundamental relationships of plants to the soil and air. They may also be trained in certain simple operations, such as the sowing of seeds, the propagation of plants by cuttings, and perhaps such operations as budding and grafting, and these exercises may—and it is very desirable that they should—extend to simple operations conducted in a school garden, where the pupils may learn something concerning the handling of soil, the arrangements necessary for the cultivation of simple crops, probably principally of culinary vegetables, and of the various incidents requiring the attention of the cultivator in order to bring these crops to maturity, such matters as watering and the protection of the crop from insect pests, all of which, if judiciously handled by the teacher, afford rich stores of material of educational value, and enable, even in simple minds, an appreciation to be arrived at of the fundamental facts in the life of a peasant.

More than this it does not seem necessary to look for or expect; indeed, if it is carefully looked at, it will be seen that it really embraces a wide range, having regard to the child mind, and, what is more, it admits of being carried into effect in practically every agricultural district, and so demands no educational revolution or upheaval.

This is, perhaps, as far as it is necessary to go in connection with the elementary school, and as far as is necessary in the case of the average child who is destined to become an agricultural labourer. Should it be desired to afford training of a somewhat more advanced and technical character, some institution other than the elementary school must be looked to.

It must be remembered that the numbers who are to receive this more advanced training will be very much smaller than those attending the elementary schools, and that the pupils so trained will stand out above the ordinary agricultural labourer, and will look for minor positions of trust carrying higher rates of wages than those of agricultural labourers.

A system of training in some institution where work is carried on for other than educational purposes seems best calculated to meet the requirements of this class.

The system may approximate to one of apprenticeship, though the use of this term, particularly in some of the West Indian Colonies, has connotations rendering it undesirable.

In most Colonies there are botanic gardens and agricultural experiment stations where there is a considerable amount of routine work, much of which is capable of being done by agricultural pupils drafted from the elementary schools. The work carried on in these institutions necessarily has a close connection with the agriculture of the neighbourhood, so that pupils can be trained in work that has real association with the local agricultural industries, and they may be trained to acquire a fair perception of the needs of these industries. Their training may consist chiefly in carrying out routine operations and in learning to perform these intelligently and dexterously. In order to minimize the danger of these pupils drifting down and being regarded merely as labourers, as well as to increase their usefulness, it is necessary that they receive a certain amount of theoretical instruction in addition to their acquiring manual dexterity in agricultural operations. This may be accomplished by giving an hour's class instruction daily, or perhaps preferably, by devoting one day a week to this form of instruction. The instruction so given should be calculated to afford an insight into the reasons underlying the operations of a practical character in which they are engaged.

It is desirable that pupils of this class should receive a small monetary payment by way of subsistence allowance; the amount must be regulated by local conditions, it should increase progressively, say, half yearly, and the acquirement of the increment should be contingent on diligent work and good behaviour.

It is undesirable that these pupils should be boarded and fed at the institution where they are trained; they and their parents or guardians should make arrangements for their living under conditions having the approval of the authorities responsible for their training. These conditions will much more closely approximate to those in which the pupils find themselves on taking up wage-earning work, while the acquiring of ability to look after their own affairs in the matter of food and clothing is training of considerable value, which is lost if the pupils are boarded and fed by the educational authority. Further valuable training, too, is acquired in that the pupils gain a knowledge of the manner of governing their conduct out of working hours, they find out how to obtain reasonable recreation, and acquire a sense of individual responsibility beyond what can be attained under a system of boarding together with its consequent rules and regulations. On leaving the institution where they have been trained in order to take up wage-earning employment the change in the manner of living is less violent, and the individual has useful experience to guide him.

Such a course of training should suffice to produce the higher grades of labourers and the types of head men who find so large a place in tropical agriculture, men who can work with their hands or, in subordinate capacities, supervise the work of others.

This perhaps suffices for the training of the scholars from elementary schools. It is now necessary to consider the facilities to be offered to those who go through the secondary schools. These cases present greater complexity, and in consequence require even more careful planning, combined with an effort to see clearly the position of each class of individual in the general economy.

Experience makes it clear that it is the duty, and that it is within the capacity of secondary schools of the grammar school type situated in agricultural districts, to afford its pupils instruction in the general principles of the sciences fundamental to agriculture, such as elementary biology, chemistry, and physics, in addition to a good sound general education, which should include the general subjects that may be classed as English, elementary mathematics, one classic, and one modern language. This instruction in science is the least that can be done, and it should be insisted on by all who are responsible for educational schemes in agricultural districts. In some cases this will constitute all the special training a youth obtains; he simply drifts into wage-earning employment, and picks up his technical training as he goes along. What is to be done in the tropics to improve upon this is a matter presenting some difficulty.

In some Colonies it is possible to afford much useful training by using the botanic and agricultural experiment stations as training ground for youths from the secondary schools, just as it is possible to use them for training pupils from the elementary schools. In some West Indian Colonies where this scheme is in operation the term "cadet" is employed to indicate the student from the secondary school, the term "agricultural pupil" being reserved for the boy from the elementary school; it will be found in practice that distinctions such as this have their value.

During the first year of a cadet's training he should remain closely associated with the secondary school, and should continue to attend such science classes as may be considered most likely to be useful to him; the remainder of each working day should be occupied in connection with the practical work of the botanic and experiment stations. The situation of botanic and experiment stations near populous centres usually minimizes the difficulties attendant upon this divided course of work. For the first year of his training, at least, a cadet should be regarded as within the jurisdiction of the school for purposes of discipline.

The kind of training a cadet may receive will depend upon the nature of the work of the botanic and agricultural experiment stations of any given district, and this in turn will be determined by the nature of the agriculture of the surrounding district. This has its advantages, for the cadet will thus find his work and training approximating closely to the requirements of the district in which he is placed and in which he may probably have to seek employment; and, further, this amount of specialization permits of a cadet being able to spend some time in more than one institution, and so acquiring, if necessary, a wide range of agricultural experience. The chain of botanic and experiment stations established throughout the West Indies offers unusually good facilities for study and training, of which advantage is being taken.

The training of a cadet embraces the acquiring of some acquaintance with the manner in which the routine office work of the institution in which he is placed is conducted. He learns how correspondence is conducted and records are kept, and participates in this work. He acquires a knowledge of the various agricultural and horticultural operations carried on at the institution, and attains some skill in the practical carrying of them out; as his experience increases he is placed in charge of minor operations, and gradually advances to the supervision of labourers and to responsibilities of a higher order; he also takes part in the experiments and investigations which are undertaken by the institution, and learns to appreciate their bearing on the agricultural problems of the district, at the same time learning the value of that accuracy and honesty of purpose which is vital to proper work of investigation.

Such training is calculated to produce in the cadet that right attitude of mind which is the aim and end of training, and which, when engrafted, results in the cadet having acquired such habits of thinking, reading, and observing that his education is life-long, and he becomes a progressive and useful member of the agricultural community. The nature of his training affords him opportunities for remaining closely in touch with the workers of the botanic and experiment stations and with the work and publications of these and kindred institutions, whereby a life-long form of education may, and does, result.

The length of time a cadet should remain under training is often determined by personal considerations, but if possible it should extend to two years, and in some cases, as explained below, opportunities for extending the training may usefully be given.

It is desirable that the cadet should receive some small sum of money weekly; while this may be regarded rather as a subsistence allowance than wages, it has useful effects in more than one direction; it is extremely useful in that it familiarizes the youth with the handling of small sums of money for his personal use, whereby he learns something of the value and limitations of money, and it also adds to his self-respect, for there is no doubt that every right-minded lad feels justifiable pride in his first earnings. Besides, the granting or withholding of small increments affords his tutors some tangible means of expressing approbation or disapproval as circumstances may demand.

A very useful purpose may be served by arranging that the cadetship of any particular place may be regarded in the light of scholarships awarded by the secondary schools of the district. It is important to maintain the intimate association between the school and the cadetship, and to insist on the continuity of the training; a system of cadet scholarships tends to ensure this.

The effort has been made in some institutions, with a certain degree of success, to afford opportunities for more extended practical training to some of the cadets by filling certain minor posts in the institution by means of cadets who are allowed to hold these posts for limited periods only, and who, at the expiration of the specified time, are required to vacate them in order to make room for others. Occasionally a vacancy may occur on the permanent staff to which a cadet may be promoted.

The training of youths in local institutions like the botanic and agricultural experiment stations is of value to parents in that the expense of the training is likely to be quite moderate and within their means, as frequently the cadet can live with his parents or relatives; it is also of advantage to employers, for the work and progress of the cadets may be kept under observation, and promising youths may be chosen to fill vacancies that arise locally.

In all of this there is little doubt as to the kind of youth to be trained or the nature of the work for which he is being trained. The cadet is taken to be a youth who has had a good grammar school or secondary school training, which includes some science subjects such as biology, chemistry, and physics, which subjects he continues to study, if possible in his old classes, for a year or so during his cadetship; he is being trained in order that he may take up work on an estate or plantation in a position of minor responsibility, with the intention of rising to positions of increased responsibility, and ultimately of complete management or control as time and circumstances permit.

It is to be observed that the systems of education so far described are in successful operation in various West Indian Colonies; in some instances it may be suggested that the work is proceeding so unostentatiously and quietly that the authorities are hardly aware that they are in possession of fairly complete and, perhaps, moderately adequate systems of agricultural education, which would be of still more service to the Colonies if they received greater official recognition. It is abundantly clear to thoughtful minds that the quiet work of the Departments of Agriculture in the advocating, and in some cases providing, agricultural education in the West Indies has already had a far-reaching effect that will be felt for some time, and this perhaps to an extent not generally recognized.

In order to make provision for those engaged in agriculture who have passed the school age and are engaged in practical, wage-earning work, the Imperial Department of Agriculture for the West Indies instituted in 1908 a series of reading courses and examinations in practical agriculture. The reading courses that are recommended cover the general ground of planting experience, and are calculated to maintain both a scientific and practical economic interest in the work of estates or plantations covering the wide range of tropical crops.

Lectures and courses of instruction are frequently arranged by the officers of Agricultural Departments, in order to assist students who are following the reading courses and preparing for examination.

The examinations are divided into three grades: Preliminary, intermediate, and final, with three classes in each grade. Except in the case of the preliminary, it is an essential condition for admission to examination that the candidate has been practically engaged in the form of agriculture for which he submits himself for examination; mere book work or class instruction is held to be insufficient to qualify for admission.[1]

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[1] Interesting information in this connection may be obtained from the following references in the *Agricultural News:* Vol. viii, pp. 90, 341, 365, 381; vol. ix, pp. 375, 381; vol. x, pp. 29, 31, 45; vol. xi, pp. 13, 29, 45, 61, 365, 381, 397, 401, 413; vol. xii, pp. 13, 29; vol. xiii, pp. 13, 29, 45, 61.

It may be briefly stated that the three grades of the Imperial Department of Agriculture examinations are made to correspond to the three grades in practical planting life. The preliminary examination is arranged to ensure in its successful candidates the amount of knowledge that may be reasonably expected in a youth leaving a secondary school to undertake the first steps in an agricultural career. The intermediate implies such knowledge, both in extent and kind, as may be reasonably expected of the young man who has had some practical experience in the more or less subordinate posts of overseer or "book-keeper," as these employés are technically termed in the West Indies, implying a good all-round knowledge of the routine work of an estate. The final examination is planned on lines calculated to inquire into the knowledge and capacity of a man capable of being entrusted with the management of an estate, who is capable of looking at agricultural questions in a somewhat broad spirit extending beyond the acquaintance with matters of estate routine. A first-class final certificate is intended to indicate a good sound knowledge of estate routine and practice (which would be indicated by the possession of the intermediate certificate), coupled with a wide outlook on agricultural affairs with some ability to deal with the more difficult abstract problems of agricultural management, all acquired in connection with practical (wage-earning) experience.

The Imperial Department of Agriculture system has been independently followed, with some modifications by the local Agricultural Departments of some West Indian Colonies which hold examinations and issue their own certificates.

The form of education just sketched may suffice for the needs of many who take up agriculture as their life's work. There remains, however, to be considered that higher form of training which may be given in an agricultural college.

It is to be expected that the training to be given in an agricultural college will be of a more academic character than that outlined under the cadet system, but this is not without its dangers, so that it is desirable there should be more rigorous and clear thinking as to the aims and ends of this training than appears commonly to exist. It is to be remembered that agriculture in its daily practice is an art rather than a science, though it makes liberal and increasing use of various sciences. There is, therefore, a danger in imagining that a knowledge of agriculture to suffice for earning a livelihood may be acquired by learning the sciences on which agriculture is based. A little thought will show that this is fallacious; this erroneous idea lies at the root of the objection of the working farmer or planter to the college trained youth, and it may be admitted that in not very remote times this objection was well founded, for agricultural colleges were, in many instances, deficient in the means of teaching the art of agriculture while equipped to teach its underlying sciences.

Another point requires careful setting out, namely, that not all who attend agricultural colleges contemplate the full practice of agriculture—that is, the raising and selling of crops—as their means of livelihood; many students look to the following of limited lines of work as specialists, either as agricultural chemists, entomologists, plant pathologists, and so forth. It is clear that these need different training from those who are destined to become the actual practising farmers or planters; in the former case the knowledge of certain sciences is all-important, requiring to be coupled with a less perfect proficiency in the arts of agriculture; in the latter the art, or arts, of agriculture are all-important, the sciences merely accessory.

In order that the agricultural college may adequately teach, even in a limited degree, the arts of agriculture, it is essential that the college shall be associated with something in the nature of a farm or experiment station where the actual agricultural operations of the district are carried on; unless these operations are conducted on a fairly large scale and, indeed, in almost any case, the knowledge to be gained will lack fulness and completeness, so that the student of an agricultural college will benefit by spending some time upon a farm or plantation, in addition to his work at the college.

The advantages offered to the student of an agricultural college over those afforded to the cadet lie rather in the wider scope of general education than in advantages in learning the art of agriculture; they imply that the agricultural college student has larger resources in the way of time and money, which he can afford to spend in acquiring his training. On completing his training, it is conceivable that the agricultural student from the college may be less mature than the cadet; he will, however, have had a wider education, and may be expected to be able finally to advance to higher responsibilities than the cadet.

In affording training for the agricultural specialist the agricultural college may be expected to achieve success, for the requirements of the specialist may, to a large extent, be taught in class-rooms and laboratories, aided by such surroundings in the way of trial plots or experimental stations as may be expected at a college. But even in this work it is essential to have access to agricultural matters in their broad practical aspects, for it will be necessary to study the practical bearing of the various scientific matters in which expert knowledge is acquired and to which it is to be applied.

It is clear, then, that agricultural colleges, in order to be successful and to discharge their varied functions in the way of educating for subsequent broad training the youths who are to become farmers and planters, and in order to afford adequate training for agricultural scientists, must be planned on very broad and generous lines. They must be sufficiently large to warrant the existence of competent and diversified staffs of teachers, each of whom is thoroughly equipped to deal with his special subject, and they must be in possession of, or associated with, a considerable area of land on which the staple agricultural industries of the country are carried on on a commercial scale. These points imply that there must be a comparatively large number of students in order to justify the expenditure in providing the equipment for their training, and there must also be assured a demand for the services of the varied classes of students turned out by the college.

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Having these considerations in view, it is evident that it will be inexpedient to attempt to establish agricultural colleges in small communities or in places where communication is in any way restricted; such institutions must, for success, be placed in prominent centres of thought and agricultural effort.

It would be of immense advantage if an agricultural college could be associated with an institution devoted to the work of agricultural research; indeed, agricultural research would be the vital stimulus of a healthy, active group of men charged with the duties of educating along various lines the students already referred to.

In planning an agricultural college, therefore, it will be of great service if the fundamental ideas can be so enlarged as to include both for the professional staff as well as for the advanced students the definitely considered duty of research. In the minds of many who seek the aid of scientific experts in agricultural subjects there exists, in a more or less pronounced degree, the idea that knowledge concerning most of the operations and requirements of the farm or plantation is fairly full and complete, and that a competent adviser should be able, with comparatively little effort, to give at short notice a satisfactory answer to most inquiries presented to him; it is little realized how scientific knowledge has grown in the last half century, and how in this growing knowledge wider vistas of the unknown and unexplored have come into view. Only those who are working and teaching along the lines of the forefront of agricultural knowledge fully recognize how much there is now that demands investigation and experiment for elucidation. An institute of agricultural research appears to such perhaps to be more of a necessity than an agricultural college, but it is also clear to them, and perhaps to the majority, that an institute of agricultural research would be the ideal organization on which to engraft agricultural teaching.

A further useful association on the part of an agricultural college, particularly for purposes of teaching and training, is an intimate connection with a Department of Agriculture of the kind now to be found in many colonies. The work of a Department of Agriculture brings it into intimate connection with the agriculture of a district in all that concerns general development and progress, as well as in connection with the work of combating and controlling pests and diseases. By the intimate association of an agricultural college with an Agricultural Department it will be possible for advanced students to be afforded opportunities of studying real practical problems, and of taking part in real live work connected with the subjects of their special study. With such an association it will be possible also on occasion to place particular pieces of work in the hands of advanced students, whereby under adequate guidance they may acquire and exercise responsibility and originality in an extended degree not readily obtainable in the narrower confines of the college.

It is unnecessary here to attempt to do more than indicate in the briefest outline the equipment required in an agricultural college, which one may now think of as including or being based on an institute of agricultural research. Obviously, this must include an adequate professional staff capable of teaching and investigating in regard to chemistry, physics, botany, mycology, zoology, entomology, veterinary science, agriculture, and horticulture, and also the work involved in the specific industries coming within the scope of the college, such as, for example, in connection with tropical agriculture, the cultivation and preparation of such products as sugar, cacao, tea, coffee, spices, rubber, starches, fibres, fruit, and a host of others.

In conclusion, it may be stringently urged upon all those giving consideration to the providing of agricultural education that they carefully bear in mind the capabilities and needs of the many classes of students, ranging from the agricultural labourer to the scientific expert dealing with only a limited range of subjects, and that in putting forward any scheme of agricultural education they should both ask themselves and answer the questions: What is the aim and object of the training offered? What class of person is it designed for? And what kind of life-work (wage-earning work) is he to be expected to undertake when he has received the training proposed?

Further, it is essential to distinguish between those who have in their life's work to regard agriculture as an art, as a thing to be done, and those who have to pay regard to the sciences underlying the agricultural arts, and, what is of great importance, to distinguish between those—the majority—who have to acquire familiarity with the arts of agriculture, but who have the opportunity and the desire to extend their education by learning much of the sciences on which these arts are based, without it being incumbent upon them to practise these sciences in their abstract form, and those who are destined to deal with the sciences fundamental to agriculture, but who have only an indirect concern in the agricultural arts themselves. To the former the sciences are accessory and in the nature of true education; to the latter they are fundamental and the ground of their life's work. Clear appreciation of this fundamental distinction will prevent the tendency to offer the budding farmer or planter fragments of science and to lead him to think that a knowledge of these constitutes his training. It will also lead to the practical farmer or planter's understanding and appreciating the scope of the work of the scientific experts, whether chemist, mycologist, entomologist, or what not, and to his intelligently and appropriately seeking their aid.

It is worth noting, in conclusion, that advantage has been taken by several students for the purposes of post-graduate study of the facilities afforded by the Imperial Department of Agriculture for the West Indies working in association with various local governments and proprietors of factories and plantations. Five University graduates have received assistance in entomological studies. One student followed a two years' course of study in sugar production under the direction of the Imperial Commissioner of Agriculture in connection with a travelling scholarship awarded by the Government of India, and one graduate from Cambridge is following a course of study in practical agriculture.

## GLI STUDI DI AGRICOLTURA COLONIALE IN ITALIA E L'OPERA DELL'ISTITUTO AGRICOLO COLONIALE ITALIANO.

Per il Dott. Gino Bartolommei-Gioli.

*Direttore dell' Istituto Agricolo Coloniale Italiano.*

L'Interessamento pubblico per le questioni agrarie coloniali, e più specialmente dei tecnici e degli scienziati pei vasti e nuovi problemi dell'Agricoltura Coloniale, di data assai recente in Italia onde è facile a chiunque segnalarne il risveglio e il successivo promettente progresso. I primi acquisti territoriali africani misero in evidenza la nostra insufficiente preparazione ad affrontare l'opera di messa in valore dei nuovi territori e persuasero alcuni studiosi della necessità di rivolgere le loro indagini a così nuovi problemi. Talchè possiamo dire che ad ogni ulteriore accrescimento del nostro impero coloniale, tenne dietro una benaugurante fioritura di pregevoli contributi scientifici in questo ramo della moderna agricoltura.

E' vero che l'Italia, già prima di possedere colonie proprie, aveva largamente contribuito con la sua gente a costituire su territori stranieri importanti centri di colonizzazione rurale, ma è anche vero che la natura della nostra emigrazione, eminentemente proletaria, le difficoltà che avrebbe dovuto superare chiunque si fosse dedicato a siffatti studi tecnici scientifici in paesi stranieri, e, quello che più conta, molto distanti dal nostro, non valsero a decidere gli studiosi italiani a dedicarsi risolutamente alle questioni agrarie coloniali. E se oggi pure i problemi tecnici ed economici del colonizzamento agricolo, che ci si presentano fuori dei territori di diretto dominio, attraggono l'attenzione degli scienziati italiani, ciò è dovuto principalmente al cresciuto ed ancora crescente interessamento offerto dalle questioni attimenti ai nostri possedimenti coloniali.

Infatti i nostri studiosi di cose agrarie ricevettero i primi efficaci incitamenti ad affrontare i problemi coloniali quando, or non è molto, una più esatta cognizione dei compiti da assolvere nelle nostre colonie territoriali allargò le basi della coscienza coloniale italiana. E poichè è compito di questa breve memoria di far conoscere quello che in Italia si è fatto negli ultimi anni per promuovere, indirizzare e disciplinare la coltura agraria coloniale, così tralasceremo di menzionare alcune istituzioni che contribuirono in varia misura ad orientare la nostra attività scientifica verso le indagini coloniali, tanto più che della loro opera sarà reso conto in questo convegno internazionale. Parimente ci asterremo dal riferire sull'attività sperimentale spiegata in Eritrea, Somalia e Tripolitania e sugli studi preliminari che ne determinarono l'indirizzo, la scarsità dello spazio imponendoci di restringere la nostra trattazione al solo Istituto metropolitano che, obbedendo alle necessità dimostratesi nella nostra azione coloniale nel campo agricolo, ha voluto e saputo in un tempo breve costituirsi quale unico centro della coltura agraria coloniale fra noi. Dandogli vita, i suoi promotori hanno voluto creare un nuovo centro della coltura italiana, scientificamente e tecnicamente inteso alla risoluzione dei più importanti problemi coloniali e cioè di tutti quelli che si prefiggono una più precisa conoscenza della messa in valore dei territori extra-europei, ove l'Italia ha o potrà avere interessi politici ed economici.

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Fino dal 1904 si iniziarono gli studi e si presero i primi accordi per la fondazione di un Istituto Agricolo Coloniale Italiano che doveva proporsi gli scopi seguenti: di funzionare come centro di informazioni, di consulenza e di propaganda per quello che riguarda l'Agricoltura, la Zootecnia e le risorse naturali delle colonie politiche ed etniche; di preparare personale tecnico, sia direttivo, sia subalterno, per le imprese agricole e zootecniche coloniali; d'integrare l'opera dei servizi agrari sperimentali governativi delle nostre colonie territoriali; di introdurre in Italia nuove pratiche agrarie e zootecniche, nonché piante ed animali da allevamento da paesi extra-europei, e studiare colture o allevamenti già introdotti e non abbastanza sperimentati, capaci di arricchire la nostra produzione, agricola e zootecnica, ed infine di stabilire le relazioni con istituzioni stromiere per gli opportuni scambi di materiale e di notizie e per far figurare degnamente anche all'estero il nostro paese in questo campo di studi. Una parte di così vasto programma poté ricevere pratica attuazione nel 1906, e nel 1908 l'Istituto Agricolo Coloniale Italiano entrò nella fase della sua piena attività funzionale. Oggi l'Istituto Agricolo Coloniale Italiano esplica un crescente lavoro in ciascuno degli organi che lo costituiscono e ciò mercè il concorso finanziario di enti governativi e locali, con l'appoggio di varie istituzioni cittadine, valendosi del ricco materiale dimostrativo, didattico, scientifico, raccolto nel suo museo di prodotti agrari, nella sua biblioteca, nei suoi laboratori, nelle serre, mediante un personale non da oggi soltanto preparato alle indagini coloniali, ma bensì allenato da lunghi studi e da un tirocinio fatto in paesi coloniali.

A questo punto, innanzi di riferire circa l'attività esplicata dall'Istituto, giova rilevare alcune fortunate circostanze che indubbiamente influirono sul suo fortunato sviluppo. E fra queste la posizione geografica di Firenze, ma più ancora le sue ricche e gloriose tradizioni scientifiche ed agricole, il fiorirvi già di istituzioni che tanta affinità hanno con quella di cui parliamo. Infatti la collaborazione, che sino dai primi giorni le accordarono disinteressata ed intera alcune istituzioni locali, resero possibile all'Istituto di affermarsi solidamente, malgrado modesti contributi di una suppellettile scientifica che sarebbe stata scarsa, ove a sopperire a tale deficienza iniziale non avessero contribuito largamente gli istituti agrari e botanici, i musei, le biblioteche, i laboratori onde è ricca Firenze. E fra queste istituzioni benemerite debbono essere principalmente nominate: la R. Scuola di Pomologia, Frutticultura e Giardinaggio, il R. Istituto Botanico, la R. Stazione di Entomologia Agraria che tuttavia continuano a contribuire all'azione dell'Istituo nel campo pratico e scientifico.

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Ed ora alcune parole circa l'azione da esso svolta e che può riconnettersi a tre funzioni principali: didattica, di propaganda e di consulenza, pure dipendendo da esse speciali organi ed uffici.

L'azione didattica si esplica mediante: (*a*) Una scuola teorico-pratica di agricoltura coloniale; (*b*) un Corso Superiore di Agricoltura Coloniale; (*c*) un Corso superiore di Medicina Veterinaria Tropicale.

L'insegnamento del Corso teorico-pratico si svolge in due anni di cui il primo è preparatorio; al primo anno sono ammessi i licenziati delle Scuole Pratiche di Agricoltura, mentre al secondo (complementare) sono ammessi, oltre i giovani che hanno frequentato con esito favorevole quello preparatorio, i licenziati delle Sezioni di Agrimensura, Agronomia e Agricoltura dei R. Istituti tecnici e i licenziati dai Corsi Superiori delle R. Scuole speciali o da altri Istituti Italiani od esteri di carattere superiore. Le varie materie d'insegnamento sono le seguenti: —

1° *Corso.*—Agronomia coloniale, Botanica generale, Scienze naturali applicate all'Agricoltura, Matematica applicata (con esercizi di topografia, estimo e contabilità), Meteorologia e Geografia coloniale, Lingua francese.

2° *Corso.*—Agricoltura comparata e coloniale, Geografia botanica, Fitografia e Patologia delle piante coloniali, Tecnologia chimico agraria coloniale, Economia e Tecnica delle aziende agrarie coloniali, Geografia economica, Legislazione e Storia delle Colonie, Zootecnia coloniale, Igiene coloniale, Entomologia agraria coloniale, Lingua francese, Lingue estere (Inglese, Spagnola, Araba, a scelta).

Per accordi presi gli allievi compiono il loro tirocinio pratico nella vasta azienda orticola della R. Scuola di Orticoltura, Pomologia e Giardinaggio, nonché nelle ampie serre dell'Istituto.

I Corsi teorici sono avvalorati da numerose esercitazioni nel Museo, nel Laboratorio, nella Biblioteca ed integrate da un viaggio di studio eseguito mediante un Campo mobile e da gite d'istruzione.

Una Stazione meteorologica serve ad addestrare gli allievi nelle determinazioni riflettenti la climatologia agraria.

Inoltre, per completare il tirocinio pratico dei licenziati nel luogo stesso ove intendono di esercitare il loro ufficio di agenti agrari coloniali, accordi sono stati presi e si continuano a prendere con Istituzioni Agrarie Sperimentali e private aziende delle nostre Colonie e di paesi di immigrazione per far loro acquistare la completa conoscenza del nuovo ambiente agricolo sociale ed economico.[1]

Il *Corso Superiore di Agricoltura Coloniale,* della durata di 2 a 4 mesi, è tenuto principalmente a laureati in Scienze Agrarie per diffondere lo studio delle questioni agrarie coloniali fra quelli che, dal loro titolo di studi, sono già designati a dirigere le sorti della produzione agricola nazionale; ma può essere utilmente frequentato anche da laureati in Ingegneria, in Scienze Naturali, in Farmacia, in Zooiatria e in Scienze Commerciali. Le materie svolte durante il primo corso di insegnamento sono le seguenti: —

Geografia coloniale, Geografia botanica, Meteorologia agraria coloniale, Colture coloniali, Tecnologia coloniale, Zootecnia coloniale, Economia agraria coloniale e Cenni di Ingegneria coloniale, Storia delle Colonie, Economia e Legislazione coloniale, Profilassi delle malattie infettive coloniali dell'uomo e del bestiame.

Durante lo svolgimento del Corso in quest'anno, è stato pure tenuto un ciclo di lezioni sull'Argentina agricola e una serie di conferenze da personalità coloniali italiane per illustrare le nostre colonie politiche e di popolamento.[2]

Il *Corso di Medicina Veterinaria Tropicale* è tenuto ogni anno ai laureati in Zooiatria allo scopo di far conoscere la Eziologia e la Patologia della maggior parte delle infezioni e per illustrare le malattie tropicali e sub-

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[1] Il numero degli allievi iscritti fino al 6° anno dall'apertura del Corso Teorico-Pratico fu di 98 di cui 53 licenziati. A 22 di questi l'Istituto ha procurato un decoroso collocamento fuori d'Italia (Argentina, Australia, Brasile, Eritrea, Montenegro, Singapore, Somalia Italiana, Texas, Niassaland, Africa Orientale Tedesca, ecc.) gli altri adempiono o dovranno presto adempiere agli obblighi di leva, o hanno trovato impiego in Italia; di alcuni è imminente il collocamento.

[2] Si iscrissero al 1° Corso di Insegnamento N° 36 laureati e uditori.

Alla fine del Corso hanno conseguito il diploma, in seguito ad un esame collegiale, N° 22 laureati e l'attestato di frequenza N° 2 uditori.

tropicali degli animali domestici nei riguardi specialmente di una razionale profilassi.

Le materie d'insegnamento del Corso sono le seguenti: Geografia coloniale, Zootecnia coloniale, Entomologia veterinaria coloniale, Patologia tropicale, Igiene veterinaria tropicale, Esercitazioni pratiche di Batteriologia e di Clinica.[3]

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Seconda per importanza è la funzione di propaganda esercitata dall'Istituto. A questa collaborano i suoi principali organi ed il personale tutto a seconda delle proprie competenze. Ma se il Museo, la Biblioteca, le raccolte di materiale dimostrativo, insieme a speciali cicli di conferenze sopra determinati argomenti che interessano i problemi coloniali, valgono a risvegliare in coloro che frequentano l'Istituto il gusto per così nuovo ordine di studi, ancora più attiva è l'opera di divulgazione che l'Istituto stesso svolge presso un più grande pubblico a vantaggio delle questioni agricole coloniali per mezzo di alcune sue speciali pubblicazioni.

La Rivista "L'Agricoltura Coloniale" organo dell'Istituto e dei Servizi Agrari dell'Eritrea, della Somalia Italiana e della Tripolitania è entrata col 1914 nel suo VIII anno di vita; si pubblica in fascicoli mensili di 60 a 80 pagine riccamente illustrati e contiene monografie e memorie scientifiche, note pratiche ed articoli di propaganda, un abbondante notiziario, numerose note bibliografiche e gli atti dell'Istituto.

La Rivista si vale di corrispondenti tecnici all'Estero e di collaboratori in Italia scelti fra le persone più competenti.

Mancando l'Italia di una letteratura agraria coloniale, l'Istituto dirige la pubblicazione di due serie di opere, una sotto il titolo di "Biblioteca Agraria Coloniale" di cui sono già usciti 10 volumi e due sono attualmente in Corso di stampa; l'altra intitolata "Relazioni e Monografie Agrarie Coloniali" di cui sono stati pubblicati due

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[3] Durante l'anno 1912 frequentarono il Corso N° 24 laureati e nell'anno 1913 n. 18. In seguito ad un esame collegiale ottennero il diploma N° 42 laureati in Zooiatria.

volumi. L'Istituto ha altresì iniziato la pubblicazione di brevi guide pratiche per l'emigrante agricoltore.

Nè ciò basta, poichè da questa azione di propaganda si può far dipendere un altro importante servizio esercitato con fortuna dall'Istituto. Vogliamo dire del Servizio Agrario sperimentale.

Con esso l'Istituto ha già incominciato lo studio sperimentale di piante nuove o poco studiate nella nostra agricoltura, ha provveduto ad introdurre nuove razze di animali domestici in Italia ed a diffondere pratiche agrarie, che hanno avuto grande successo all'Estero. Esempi di questa attività sono specialmente le *ricerche sperimentali di cotonicoltura* nel mezzogiorno d'Italia e nelle isole, eseguite per incarico del Ministero di Agricoltura, le prove colturali di numerosi foraggi propri dei paesi aridi, l'importazione di ovini *karakul* in Sardegna per migliorare le razze indigene, l'aver contribuito all'introduzione di riproduttori zebù per prove di acclimatazione e di incrocio nel nostro paese, la pubblicazione di note critiche e monografie descrittive sui più noti metodi di "*arido-coltura*" e sugli studi che in materia vengono eseguiti nelle diverse regioni dell'Africa, dell'America, dell'Australia, ecc.

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Connessa intimamente alla funzione di propaganda è quella di consulenza che costituisce uno dei più importanti servizi a cui abbia dato vita l'Istituto. Essa si esplicò attivamente fino da principio, personalmente e per corrispondenza, e si svolge in modo speciale con pareri, esami di progetti tecnici, provvista di materiale diversi per privati e per Enti governativi Italiani della metropoli, e delle colonie nostre e dell'estero (Governi delle Indie Inglesi e Olandesi, del British East Africa Protectorate, Deutsche Ost Afrika, Tunisia, Messico, Egitto, Francia, Spagna, ecc). Il numero dei corrispondenti con cui l'Istituto fu in relazione per consulenza tecnica, informazioni e commissioni è rilevantissimo. Sempre in ordine a questa funzione, e per sua iniziativa e il più delle volte su richiesta di Enti governativi o di imprese private, l'Istituto ha provveduto e partecipato con personale proprio o anche valendosi di tecnici e scienziati adatti allo scopo, e da esso non dipendenti, all'organizzazione di importanti missioni di studio compiute tanto nelle nostre Colonie quanto in quelle di altre nazioni.[4]

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[4] Fra le missioni di studio sono da annoverarsi le seguenti :—

(1) La Missione del Dott. Guido Mangano nella Somalia Italiana, nel British East Africa, Deutsche Ost Afrika, e Zanzibar come addetto tecnico dell'On. Leopoldo Franchetti (Marzo-Luglio 1908).

(2) Missione di studio eseguita pure dal Dott. Guido Mangano nell'India, Ceylon, Penisola di Malacca, Giava, Eritrea, Egitto (Agosto 1908—Marzo 1909).

(3) Missione di studio del Dott. Guido Mangano nelle principali istituzioni agrarie coloniali della Francia, Belgio, Olanda, Germania (Giugno 1910).

(4) Viaggio di studio del Dott. Guido Mangano per visitare le Tripolitania e Cirenaica per incarico della Società per lo Studio della Libia (Giugno 1912).

(5) Missione di studio del Dott. Dino Taruffi nell'Angola per incarico del Sindacato Italiano per Imprese nell'Africa Occidentale (Agosto-Dicembre 1912).

(6) Missione di studio dell'On. Prof. Carlo Pucci, Proff. Manetti e Pampanini nel Gebel Tripolino come tecnici della Missione Franchetti della Società per lo Studio della Libia (Febbraio-Giugno 1913).

(7) Missione di studio dei Proff. G. Stefanini e G. Paoli per indagini geo-idrologiche e naturalistiche nella Somalia Meridionale per conto del Governo della Somalia Italiana (Aprile-Dicembre 1913).

(8) Missione di studio del Dott. Guido Mangano in Eritrea per conto della Società per la Coltivazione del Cotone (Ottobre 1913-Gennaio 1914).

Tali Missioni oltre a contribuire all'allenamento del personale, giovano ad arricchire notevolmente la suppellettile scientifica dell'Istituto e le sue pubblicazioni.

L'Istituto Agricolo Coloniale Italiano ha dotato inoltre le seguenti missioni di istruzioni e di materiale scientifico per la raccolta di prodotti e di notizie agrarie :

Missione dei Dott. Scassellati e Mazzocchi nella Somalia Meridionale.

Missione del Maggiore Tancredi al Lago Tsana.

Missione del Cap. Citerni nell'Etiopia Meridionale.

Missione della Società Italiana per lo Studio della Libia in Tunisia e nella Tripolitania.

Missione del Col. Miani nel Fezzan. Ha pure prestato assistenza a numerosi viaggiatori ed esploratori che per ragioni di studio o di commercio, hanno compiuto viaggi nei paesi coloniali.

La brevità dello spazio non ci consente di dare risalto ad altre secondarie attività dell'Istituto, e nemmeno ci permette un' adeguata descrizione degli organi da cui emanano queste diverse attività.

Ma pur volendo tacere di altre numerose iniziative prese dal nostro sodalizio in breve volgere di tempo, giova ricordare l'aiuto che l'Istituto prestò alla Società Italiana per lo Studio della Libia che sino dal suo nascere assisté con l'opera e col consiglio del suo personale tecnico nella esecuzione di quella parte del suo programma di studio che rientra nella nostra funzione di consulenza.

Parimente dobbiamo rammentare che la Direzione dell'Istituto nel 1910, essendo stata incaricata dal Ministero di Agricoltura, Industria e Commercio di rappresentare l'Italia e di promuovere la partecipazione al Congresso di Agronomia Tropicale a Bruxelles, disimpegnò il compito assuntosi facendo figurare degnamente gli studiosi italiani in quella riunione scientifica.

Nè a questo punto è fuor di luogo il ricordare che in seguito a sua iniziativa l'Istituto, aderendo alle reiterate insistenze dell'Associazione Scientifica Internazionale di Agronomia Coloniale, addivenne alla costituzione della Sessione Italiana dell'Associazione stessa: ognuno comprende con quale vantaggio per la stabilità e l'intimità dei rapporti scientifici fra i nostri studiosi e quelli degli altri paesi coloniali.

Ond' é per noi ragione di legittimo orgoglio e di intima soddisfazione poter oggi fare udire in seno alle solenni riunioni di questo Convegno Internazionale la voce dell'Italia recante il suo primo contributo in questo nuovo ordine di studi, al quale soltanto da pochi anni si è dedicata, col consueto fervore, e facendo concoscere nel contempo la parte avuta in questo risveglio dall'Istituto Agricolo Coloniale Italiano. E vogliamo sperare che da questa sommaria esposizione di notizie e di opere possa resultare come la nostra fondazione sia il centro di studi che si dimostra attualmente il più adatto a promuovere gli studi agrari coloniali in Italia, e a dar loro un sempre crescente incremento; l'Istituto nazionale insomma da cui nell'ultimo sessennio è sorta la maggiore copia di impulsi alla soluzione dei problemi coloniali.

## THE NECESSITY OF ESTABLISHING A BRITISH AGRICULTURAL COLLEGE IN THE WESTERN HEMISPHERE.

By HAROLD HAMEL SMITH.

*Editor of "Tropical Life."*

As some apology or explanation, perhaps, is due from me for introducing at this Congress what might, at first sight, appear to be purely a national question relating only to this country and its dependencies, I would urge that nothing to do with the tropics, and especially with the cultivation of crops within their area, can be regarded as purely a national matter. Such reasons as the facility with which pests are spread, rainfalls encouraged or adversely affected, the distribution of seeds and plants, and so on, render it absolutely necessary that everyone going to the tropics to plant, or even to trade in the produce, should be trained beforehand along right lines within the Torrid Zone, so as to be able either to check and put an end to trouble should it arise, or more important still, to learn how to avoid causing it. In order, therefore, that those who wish to plant or trade within the Torrid Zone should receive that training which is necessary to enable them to do so with the greatest chances of success, I have chosen, as the subject of my paper, "The Necessity of Establishing a British Agricultural College in the Western Hemisphere."

Before I go on to say one word in support, not so much of the claims of the West Indies for an Agricultural College as to show the absolute necessity of this country, if it means to enjoy that share to which it is entitled of the ever-increasing commerce of Latin-America, to establish such a college in the Western Hemisphere, I want it to be clearly understood that I am not urging the claim of the West Indies in competition with Ceylon, for such is, in no wise, my desire. On the contrary, if, *pro tem.*, there is to be only one college, then I agree that Ceylon should have it; but what I do maintain is this—and I maintain it as emphatically as I can—that our welfare as a trading nation, as well as on account of our Imperial interests in the West, renders it quite as important—and perhaps more so—that we should establish a college in the Western Hemisphere, as it is that we should have one in the East.

Estimates as to the cost of a college, as well as of the annual amount necessary for its upkeep, vary considerably. It has, however, been estimated by the President of this Congress, Professor Dunstan, that £50,000 would be sufficient to establish a college in Ceylon on a secure basis. To this, of course, as time goes on, other amounts could be added from private sources. If it is so in the East, it would certainly be so out West, where the cost should not exceed that which is necessary in the East; this being so, someone has to put down £100,000 sterling to establish the two colleges to commence with, and those who do so will get better value for their money than any shareholders receive in any three of the best paying rubber estates, although they have already got back their capital several times over.

There is, of course, only one source from which such a sum can come, namely, the general public, who will benefit by the establishment of the two colleges in every possible way, both as regards the assurance of increased supplies of raw materials for their factories, as well as the large shipments of foodstuffs which we now draw weekly and daily from the tropics, and without which the bulk of the population in this country, and the rest of the world generally, would find it difficult—if not impossible—to exist for more than a few months. The importance, therefore, of scientifically training tropical agricultural experts and planters is not confined to any one country, but is quite international in character.

We must agree that the Government of this country will have to find the money, and in saying this we do not think, when the public who are behind the Government realize the exact state of affairs, that they will grudge such a small amount. I say this, because in April last I noticed that Uganda was to have a loan of £3,000,000 sterling to increase its general efficiency, and from all accounts the money was badly needed, and will give an excellent return.

Glad as I am, glad as everyone who knows Uganda and the possibilities of trade that surround it must be, that the Protectorate has received this amount, no one can compare the importance of Uganda as a trading and agricultural centre, with the Far East on the one hand, or of Latin-America on the other. If, therefore, the Government has seen its way to vote £3,000,000 sterling for Uganda, it certainly, if it knows its work and can realize the immense benefit these colleges will be to our trade and commerce generally, cannot hesitate to vote the £100,000 sterling to found two Agricultural Colleges and Institutes of Tropical Research, one in the East—say in Ceylon—and a second in the West—let us say in Trinidad.

Before going on to discuss the class of student that I am hoping to see make use of these colleges—for I believe that there is some difference of opinion as to who will enter their doors—I would like to call your attention to the enormous amount of British capital that is now invested in Latin-America. I am quoting the following figures from the *South American Journal* of January 7 last, and therefore can claim that they are well up to date. According to this authority, the total capital invested in the Spanish and Portuguese Republics amounted to £1,001,736,565 sterling, which you will agree is a very substantial sum.[1]

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[1] According to a statement in *The South American Journal*, January 7, 1914, the eighteen Republics of Latin-America occupy a total area of over 8,000,000 square miles, having, according to the latest estimates, 75,000,000 inhabitants, with a total trade of £560,000,000 per annum, of which that with Great Britain accounts for £125,000,000, whilst the amount of British capital invested in each country, together with the total (£1,001,000,000) is as follows :—

On the other hand, if you read the books that have appeared lately by reliable authorities on the immigration into Latin-America of all classes, you will have learnt, with regret, that at the chief commercial and social centres the number of British subjects tends to go back instead of going forward. I will only quote one instance. Mr. Reginald Enock, in his book on the "Republics of Central and South America," told us that out of the total immigration into Brazil during 1911 (134,000 souls) only 5,850 were British, and from the figures of 1912 and 1913, I should say, without being certain of the fact, that this difference was even more marked than it was shown to be in 1911. Mr. (now Viscount) Bryce also calls attention to the scarcity of English-speaking people in Latin-America, for you may remember that in his book on "South America: Observations and Impressions," he quotes, on p. 510, the saying of Mr. Hiram Bingham, "that the educated young German who is being sent out to capture South American commerce is a power to be reckoned with."

Do you not think that this is a very serious matter? We are investing our hard-earned savings in another country which, if we are not careful, and if we do not increase by two- and threefold the number of our own countrymen to represent us (better still, were they twenty times the number that they are to-day), this very capital will militate against our own prosperity by generating trade which goes to other countries, who will benefit at our cost on account of their countrymen being so greatly in the majority to divert the trade to their countries.

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British capital invested in :—

| | | | |
|---|---|---|---|
| Argentina ... | £357,740,661 | Guatemala ... | £10,445,220 |
| Brazil ... ... | 223,895,435 | Salvador ... | 2,224,700 |
| Chile ... ... | 63,938,237 | Honduras ... | 3,143,200 |
| Uruguay ... | 46,145,393 | Nicaragua ... | 1,239,100 |
| Peru ... ... | 25,658,298 | Costa Rica ... | 6,660,060 |
| Bolivia ... | 419,720 | Panama ... | — |
| Venezuela ... | 7,950,009 | Cuba ... ... | 44,444,618 |
| Colombia ... | 6,654,094 | Shipping ... | 15,362,230 |
| Ecuador ... | 2,780,974 | Banks .. ... | 18,514,537 |
| Paraguay ... | 2,995,730 | | |
| Mexico ... | 161,524,349 | | £1,001,736,565 |

Far better, if we are not going to send our young men to Latin-America, not to invest our money in it; at any rate, if it is not better for the shareholders, it will be better for us from a political point of view. I believe that in Sao Paulo (Brazil) alone there was a round million of Italians in 1912 or 1911, and there must be between 400,000 and 500,000 Germans distributed throughout Brazil generally. It has been contended that the bulk of these are only workmen; this, however, does not make any difference in the regret that I feel that there is not a proportion of English among them, for if you follow the careers of some of these men and take note of the producers of the immense quantities of maize, wheat, refrigerated meat, etc., that is leaving South America every year, you will find that many of those who went out as common labourers are now men of extreme wealth, and are dominating the production—if not the export—of these valuable shipments; and what other nations can do, I maintain that the Englishman can do in the same way. What the actual number of Englishmen are in that Republic I cannot say, but from all accounts the proportion is very small indeed, although out of our thousand millions invested in Latin-America, one-fourth, or 224 millions, are invested in Brazil alone.

I believe that even in Argentina, which claims 358 millions of our money, the English population is almost at a standstill—at any rate, it is not increasing at the rate it should do—and I gather that throughout Latin-America you will find it is the same thing, only far worse, in countries outside of Brazil and the Argentine.

In urging, therefore, that this country *must* have an agricultural college in the West Indies, I am not thinking of these islands alone, but am urging this in order to induce young Englishmen to go out to Latin-America generally to look after and develop our interests there, and so divert the trade to this country instead of allowing it to be developed by other nations, who naturally will send the trade to their own countrymen, and not to us.

There is another point in favour of a second college to be established in the West Indies, which, it must be remembered, can be securely established for the sum of £50,000 to £100,000 sterling at the most, and it is that at such a centre a man could be easily and properly trained to go across to the West Coast of Africa to take up the imperial work of forestry and agricultural instruction that is shown to be so extremely necessary if the nations dependent on agriculture in the Black Continent (and, after all, everybody is dependent directly or indirectly on agriculture and the products of the soil) are not to suffer a serious set-back for the following reason:—

"There have long been complaints that South Africa is getting drier every year, and this has generally been ascribed to the destruction of trees." Such is the opening sentence to a short editorial note in the April number of the *Colonial Journal.* In the second edition of my book on the "Cultivation of Coco-nuts," I deliberately included a short section at the extreme end of the book on this very danger of deforestation to Africa, and, quoting the report of the Royal Commission on Indian Finance, I show that not only does the deforestation of Africa tend to adversely affect the agricultural interests of that country, but also of India, since we are told that by one of the most stupendous miracles of Nature—the source of the rainy season, that is—the monsoon in India is derived from the heart of Africa. I do so because, although South Africa does not include the West Coast, yet I feel that, since we have got the Sahara up in the North, and such a report has been sent in from the South, there is danger if precaution is not taken in time, that the centre, or equatorial portion of Africa, may become affected in the years to come and lose the great fertility that it now boasts of, by means of which it is putting out huge exports of cacao and oil palm products, of which both this country and the Continent of Europe stand in such need. Ignorance, therefore, through lack of training, may cause our officials in the Black Continent to be indifferent to the deforestation of Africa, or to prove unable even to check this drying up of the African Continent complained of, which, should it occur, must, from all we are told, first turn Africa into a veldt, and then a desert, and bring ruin and famine not only to Africa, but to India as well.[2]

To establish a college in West Africa is, for many reasons, impossible; but, as already stated, since a good many men who have been trained in the West Indies, and especially in Trinidad, have done and are doing well in West Africa, it seems possible that Government irrigation and forestry officers and other experts that Africa will need could be well grounded in the Agricultural College and Institute of Tropical Research in the West Indies, and so do better work in Equatorial Africa than would be possible if they were trained in the East, where the native labour, as well as the climate and other conditions, are so different to the two Continental coast lines washed by the Atlantic.

You will notice that in this paper I have not gone into

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[2] As regards this effect one portion of the globe may have upon another even when the temperature and climate is extremely different, I would call attention to what Sir Ernest Shackleton told us at the dinner given in his honour by the (London) Pilgrims Club, on April 24, when he pointed out that the ice season in the Antarctic affected the rainfall in Chile, Argentina, and, I would also suggest, along the entire coast of the Pacific side of South America, if it can be said to have any rainfall at all. " It has been found," he told those present, " that a dense ice season in the Weddel Sea meant heavy rains in Chile and the Argentine. It appeared that there was an open season in the Weddel Sea this year, with the result that the rains were not so heavy in the Argentine. If, therefore, they could get observations over a series of years in the South Polar regions, the farmers and stockbreeders of Argentina would be more or less able to regulate the water supplies and various other problems they had to contend with." Argentina and Chile, as Sir Ernest pointed out, did not belong to this country, but science (and, I would add, tropical agriculture) knows no country, and I wonder, since the Antarctic affects the rainfall in this manner in Argentina and Chile, whether it would not also affect the Australian rainfall, and hence the sheep farmers out there as well. I certainly attribute the more tempered heat and hence the greater salubrity of one side of some of the West Indian islands to their being open to the cooling winds coming up from the Antarctic, and if these islands are so affected then Australia as well as Argentina may be so.

details in favour of the West Indies, viz., their cheaper and quicker access, cheaper living without losing caste, great soil fertility, equal if not greater facilities to study all tropical crops on a commercial scale except tea, and even tea is met with in Jamaica. All I do claim for the West applies equally to the East, and it is this: If your embryo planter wishes to go planting in the West, then train him in the Western Hemisphere; and I am, as you have heard, most anxious to see a large number of young Britishers distribute themselves throughout Latin-America. But if he wishes to go East, then train him in the East, so that each will receive his tropical agricultural education amidst the same surroundings that he will have to encounter when he sets up for himself. Neither have I called in the aid of others to support my claim, but I do not do so as time is short, and also because I know that all of you, or nearly all of you who are present, have closely followed the agitation ever since Professor Dunstan first mooted the point in a prominent way at the late Mr. Ferguson's lecture at the Royal Colonial Institute in December, 1910; and I discussed his proposition at some length in *Tropical Life* in the now well-known leader which appeared in January, 1911, when I proposed that a Tropical Agricultural College should be established as a memorial to King Edward VII. All those who have followed the question as I have can tell you how the *Times*, *Westminster Gazette*, *Nature*, and other papers on this side have supported the claims of the tropics for agricultural colleges, and the West Indies in particular.

In conclusion, I would add that if this Government, or, shall I say, any Government that rules this country and its dependencies, were as keen on wringing out the labour and empire-building capacity that is latent within us all (though some are very loth to make use of it) as they are of squeezing out our money for taxes, I reckon that the development of the resources of the tropics and sub-tropics would go ahead at a much more rapid rate than it is doing at present. Why not adopt the idea of conscription to compel everyone to do his (or her) share of the work of the country, so as to develop the resources of the Empire by the united effort of all as well as for the benefit of all, either driving away the slackers or reforming their ways on a tramp-farm or labour colony? I say this because I think the bulk of those who at present work at half or quarter pressure only would be much more healthy, as they would be more useful if they worked at full pressure, and their help is certainly needed. Standing next to me at a meeting held at the Mansion House in support of the British Dominions Exhibition, to be held at the Crystal Palace next year, was Mr. Will Crooks, the well-known Labour M.P., who, in the course of his speech, claimed, and rightly claimed, that the lower classes, because they are used to rough it, were often just the very ones who got on best when they went forth into the world to make their way; and once educated men with capital who have had the advantage of being trained at an agricultural college in the tropics are induced through this training to go thence to increase our supplies of foodstuffs and raw materials, then these others will follow, especially if slackers are discouraged, if not coerced at home, and every workman compelled to do a minimum share of his country's work, in the same way as these same men are so very keen just now to compel their employers to pay them all—good, bad, or indifferent—an equal minimum wage. One day perhaps our Government will find that it is their duty to round us all up once a year, as the ranchers do their cattle, take stock of all, asking each what they are doing, ascertain what they can do, and then see that it is done. This may sound autocratic, but it will be at least fair—far fairer than the world is to-day, when a minority of us work, and work hard, to pay the major portion of the taxes and help slackers have an easy time.

Since the Government of to-day has found the money necessary to ensure the health of the workers in this country and to keep the aged from having to depend on charity, so also is it their duty—that is to say, the duty of ourselves—to spend an amount far less than 1 per cent. of the total of this year's Budget to ensure this country receiving those regular and increasing supplies of foodstuffs and raw material without which we cannot continue to be one of the leading—if not the leading—countries in the world. If on a Budget of £200,000,000 we cannot squeeze out one-thousandth part to secure our enjoying the lead in the world's commerce, then I would maintain that we should be signally failing in our duty, both to the present generation and those who are to come hereafter.

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# AGRICULTURAL EDUCATION IN THE PUNJAB: A NOTE ON SIX YEARS' EXPERIENCE IN TEACHING AGRICULTURAL SCIENCE IN NORTHERN INDIA.

By J. H. Barnes, B.Sc., F.I.C., F.C.S.

*Principal of the Punjab Agricultural College and Agricultural Chemist to the Punjab Government.*

It was in the year 1901 that Lord Curzon, then Viceroy of India, inaugurated the policy of establishing a school of tropical agriculture for India, a school which was to be a university in the breadth of its work, since it was to study agricultural problems first hand, as well as to train the Indian students in the methods by which these studies could be carried out. The Agricultural Research Institute at Pusa was the direct outcome of this policy; and the budget surplus of the year 1905-06 placed at the disposal of the Government of India funds which enabled it to expand the original scheme of one school for all India into one college for each province. There had already been in existence in India schools or colleges where tuition in such subjects as agriculture, chemistry, and botany were given, as, for example, the Poona School of Science, the Sibpur College in Bengal, the Agricultural School at Cawnpore, and the Saidpur College in Madras. There were also one or two specialists in agriculture, one of whom, Mr. J. Mollison, C.S.I., was selected by Lord Curzon to fill the post of Inspector-General of Agriculture in the new department then about to be formed. I shall pass over the work of these schools with the remark—and here I quote Mr. Mollison's personal opinion—that the results were not satisfactory; they achieved nothing. The grants which were distributed by Lord Curzon's Government in 1905 placed two and a half lakhs[1] in the

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[1] £16,667 sterling.

hands of the Government of the Punjab, a sum with which to commence operations, and the local Government added to this a further sum of one and a half lakhs,[2] and began the formation of a Department of Agriculture which, in the first instance, consisted of a civilian director, with four European experts, two agriculturists, one of whom was to be the principal of the new college and the other a district officer, one chemist, and one botanist. The site chosen for the new college was situated on a piece of land near Lyallpur in the Lower Chenab Canal Colony, land which had been reserved from the early days of the opening of the colony to serve as a Government experimental farm. Building operations were commenced in 1906, and two blocks of buildings, one consisting of laboratories, lecture rooms, offices, museums, library, etc., and the other of the laboratories and lecture rooms for the teaching of chemistry and physics. These buildings were completed in 1911, by which time a college workshop, and a small electric generating station and gas plant had been added. The total cost of the buildings was Rs. three lakhs, fifty-one thousand nine hundred and twenty-four,[3] and the fitting and equipment and scientific apparatus, tools, machinery, etc., Rs. one lakh, eighty-five thousand four hundred and twenty-five[4] more. In the equipment of the college provision was made by the Staff to carry out research work in the different sciences as well as the ordinary routine teaching. The college laboratories are roomy and well-aired; thus, for example, one of the botanical laboratories has a floor space of 51 by 31 ft. and a height of 26 ft., the whole of one side facing north being fitted with large windows, so that a microscope can be used at any point of the laboratory. One of the chemical laboratories has a floor space of 60 by 27 ft. and a height of 25 ft., and is fitted with every modern convenience, the details of all fittings having been worked out by the specialist in charge of each section. The college was opened to students in September, 1909, and a course of instruction which had been

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[2] £10,000 sterling. [3] £23,462 sterling.
[4] £12,365 sterling.

laid down by the fourth Board of Agriculture at Pusa in 1908 in the form of a standard curriculum for provincial agricultural colleges in India was started. A considerable amount of discussion had taken place on the subjects of the curriculum, the length of the course, and the entrance qualification of students. The curriculum itself was enforced by the Local Government, though the opinion of some of the members of the Staff was opposed to much of its detail. In the absence of any experience of Indian students and Indian conditions by these, however, it may be said to have been perhaps the best that could be done at the time. It has shown the disadvantages of binding an educational institute to a rigid course of studies, and the results obtained at Lyallpur indicate the necessity of rendering a curriculum based on Western methods and translated to the Orient sufficiently mobile and elastic to adapt itself to its new environment without having at the same time to break through the iron bands of officialism. The general experience throughout the whole of these colleges in India can be said to have been similar, and has found expression in the *Proceedings* of the Meeting of the Board of Agriculture in 1913, held at Coimbatore, where the abandonment of this curriculum was advised, and the substitution for it of such courses as would be felt to meet the requirements of the students in the different provinces of India. It is with my experience in the Punjab with Punjab students and teaching them the subject matter of this standard curriculum which I propose to deal in this paper, and to draw from this experience some generalizations which may serve as a guide to other teachers finding themselves placed in a similar position. The course of studies laid down necessitated on the part of the students a working acquaintance with the English language and some elementary knowledge of arithmetic, elementary mathematics, and the elements of general science (the latter being optional). These could only be obtained in students who had reached some recognized standard of general elementary education, and the standard adopted was that of the Entrance Examination (Matriculation) of the Punjab University. Doubts were expressed both by the members of the teaching staff and senior and experienced civil officers (1) as to the suitability of this entrance standard for the course of instruction to be given; (2) as to the effect which the introduction of such a regulation as this would have in weeding out a class of Indian students considered desirable, and the automatic forcing into the college of an undesirable class. Both of these fears have been more or less justified, for in the first place the experience has shown that this entrance standard does not enable the college to recruit a student qualified to attend the lectures and laboratory courses embodied in the curriculum; and secondly, the students have almost without exception entered the college solely with the object of obtaining employment in one or other branches of the public service, and not from a desire to benefit the farming classes directly or indirectly. These students, instead of coming from a farming stock, are for the most part of the Khatri or shopkeeping class, which is, in Northern India, the class most interested in education, and the one which floods the University colleges and secures the bulk of the prizes offered in the different branches of Government service and civil employ, and in the learned professions. The curriculum recommended consists of practical and theoretical instruction in agriculture, agricultural chemistry, botany, veterinary science, entomology, physics, etc.[5]

The whole curriculum was from the first arranged on the lines of the best English or American agricultural colleges, the course containing as large a proportion of practical work as could be well included, and at the same time the student was given an up-to-date account of the subjects under study.

The system of marking also aimed at minimizing the danger of cramming by allotting 40 per cent. of the whole marks obtainable in the diploma examination to work done during the three years' residence, and a 40 per cent. pass standard adopted. In this way a premium was placed on steady work, thus rendering it practically

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[5] The syllabus of the Punjab Agricultural College has been omitted.

impossible for a student of average ability to fail to obtain his diploma.

In spite of the care taken to give as good a course as possible and encouraging steady work by the students, the system has failed in two respects. It has failed in the first instance in popularity with the people of the province, for the last session opened with one student only coming forward,[6] and secondly, it has failed to produce as good a type of man as expected. I have carefully examined the causes which have led up to the fall in popularity, and I attribute it to two causes:—

(1) The lack of employment on a remunerative scale for past students of the college.

(2) The high standard of the course, for the generality of Indian students and the hardships entailed on them in keeping pace with it. The two are correlative.

In the first place the public were notified that the diploma of Licentiate in Agriculture of the Punjab Agricultural College would be considered as equivalent to the B.A. or B.Sc. of the Punjab University in educational value in the selection of candidates for employment in the provincial civil services. This certainly stimulated recruitment, since the agricultural course was only three years in length, whereas the B.A. or B.Sc. course was one of four years.

No encouragement has been given, however, to students of the agricultural college to enter the magisterial and revenue services, as the authorities consider that the college should be primarily a training ground for agriculturists or specialists in agricultural science, and not for revenue officials.

The Punjab is for the most part farmed by a class of peasant proprietors and men of small holdings. There are very few large estates in existence similar to those of the big zemindars of the United Provinces of Agra and Oudh and of Bengal. Consequently, there is practically

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[6] The latest newspaper report, May 13, 1914, states that a similar position has arisen at the Agricultural College at Nagpur, in the Central Provinces. A similar condition has been reached in Bengal.

no demand for the services of past students as managers of estates, and, indeed, during the past five years I have not had more than a dozen inquiries for qualified men, and only one or two of them offered anything like a reasonable scale of pay, these latter offers coming from other parts of India. This in no way reflects on the students of the Punjab Agricultural College as compared with other agricultural colleges in India, for the Research Institute at Pusa, which has all India to choose from for its staff, has shown a preference for my men. The students themselves are mostly too poor to afford to farm their own lands after undergoing this expensive education. There consequently remains only employment in the Provincial Agricultural Service, and in this their pay at present is on too low a scale to induce healthy competition. The employment in the Punjab Agricultural Service is at present limited to five or six recruits a year. The question of improving the prospects of these men is receiving the attention of Government, and I hope to secure a scale of pay commensurate with the time and money they have spent on their education and the salaries commanded by young Indians of similar educational attainments elsewhere.

The second cause is undoubtedly an important one also, for the students entering the agricultural college possess such a poor knowledge of English and the subjects of primary educational importance as to be unable to assimilate the college lectures, at any rate for the first six months or so. This is emphasized by the ease with which students possessing a better education than that of the University entrance standard can get ahead of their fellow students. The difficulty which the students consequently experience tends to lower the popularity of the college. It cannot be said that the standard of tuition is too high if we take into consideration the class of men we are attempting to train—men, that is to say, who are to staff the departmental farms, to assist the expert agriculturists in their district work, and to act as advisers, demonstrators, and itinerant lecturers in the districts in promulgating the methods of agricultural improvement.

The natural inferences to be drawn are that either we must raise the entrance standard of the students or we must lengthen the course of instruction given, but in both of these cases we shall be met with the difficulty of being unable to offer sufficient employment afterwards to induce candidates to come forward. I have summarized the situation in a note which is published in the *Proceedings* of the Meeting of the Board of Agriculture in India, held at Coimbatore in December, 1913 (published by the Superintendent; Government Printing Press, Calcutta, price 1s. 9d.). In this note I have shown that the cost of education in the Lyallpur College amounts to something like Rs. 8,000 per licentiate turned out (average of the last three years), and this figure takes into account only the annual recurring expenses of the institute after deducting a very liberal amount for the expenditure in time and money on the research laboratories. It is consequently a very expensive system of education, and at the same time is not yielding results proportionate to the cost. I am of opinion that the entire policy of agricultural education requires remodelling. In the first place, the results obtained in countries where farming is an important industry, and where large sums of money have been spent on its development, indicate that all attempts at improvement must be based on investigation—investigation of the causes of sterility, causes of diseases, the effect of climatic conditions, and the possibilities of improvement of land, stock, and plants. Such investigations demand a number of experimental stations for experiment and record and well-equipped scientific laboratories, where the necessary scientific inquiries can be carried out. I think we may attribute the high position held in scientific agriculture by the Department of Agriculture in the United States of America to the fact that this broad principle is being followed there, namely, that inquiry has preceded education and instruction. The second point is that experience throughout the world seems to show that technical education given in agricultural colleges to be effective should be of only one or both of the following two types:—

(*a*) Elementary instruction in the form of short farmers' classes suitable for the actual cultivators of the land, technical in character, and qualifying the students attending them to become better farmers. Such classes must of necessity be exceedingly simple, and in many cases will give empirical methods of improvement worked out on experimental stations and farms without going into the underlying scientific principle on which these improvements are based. They must in all cases be given on such farms or by men who have been trained there, for they rely for their success on a thorough acquaintance with the practical difficulties to be met and overcome.

(*b*) A course of instruction embodying the best methods of scientific investigation adopted in working out improvements. Such a course is of the highest possible type, and can be given only by men who are engaged in such investigations and at an institute fully equipped for this class of work. Such an education as this places a higher value on the student who has passed through it as a technologist than as a mere educated man. Consequently, the students passing through such a course as this go on to apply in a direct manner the education they have received.

Between these two limits agricultural education appears to result in the students afterwards taking to other and sedentary pursuits. The expense of scientific and technical education will not permit of this, and the system should aim at the waste being limited to the normal failures, which usually occur during the course. It is my opinion, therefore, that in opening an agricultural department in one of the colonies these principles should be followed, firstly, the establishment of experimental stations and laboratories necessary to collect the large amount of information which is essential to future progress. As these results begin to accumulate, the first course of instruction referred to above can be commenced with every prospect of it proving successful. For the first few years at least the higher course of instruction should be limited to the personal training obtainable under the experts and specialists in the laboratories attached to the experimental stations; and the colleges, when they are started, should be started in a conservative spirit, and where possible attached to existing universities or existing science colleges. The present position of agricultural education in India indicates that we have started at the wrong end. We have attempted to put education first and inquiry second, and we have handicapped the very limited expert staff by placing this heavy teaching burden on them. This is being done in a country where elementary education has only reached 5 per cent. of the entire population, and consequently there exists no spontaneous demand for higher education in its highest sense. Until this difficulty has passed away, I consider that we shall achieve a higher efficiency with the staff at our disposal by concentrating the higher teaching in one institute, and using all other institutes as experimental stations and schools for giving instruction of the first class. We are about to put this to the test in the Punjab by substituting for the present diploma course a two years' course of instruction, consisting almost entirely of outdoor farm work with lectures on farm subjects, a few popular science lectures, and some tuition in English and arithmetic. This course is being taken up with the approval of the Board of Agriculture in India. This two years' course will be followed by a further course of two years, in which higher instruction will be given, including agricultural chemistry and botany, and the various other subjects of the old diploma syllabus. Whether the second two years' course is given at Lyallpur or at a college central for several provinces will depend upon the number of students forthcoming. In addition to this class, there is already being given in the vernacular a course for farmers which extends over six months, and consists entirely of outdoor instruction on the farm in the use of improved implements and the application of improved methods. We have also under contemplation a class for young officers in the Civil Service, in the Irrigation Department, and for assistants in the Provincial and Revenue and Educational services. All of these men during the course of their work have to deal with a farming population, and very often with questions relating to land and crops, and it is considered advisable that they should know something of the system on which a department existing for the improvement of agriculture works.

It will be seen, therefore, that as a result of the past six years' experience an entire change of policy in agricultural education is about to take place in the Punjab; how far this change will be productive of good it is yet early to say, but I am confident that it is a step in the right direction, and that the Indian student trained under these new conditions will prove himself to be a better man than his predecessor.

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## AGRICULTURAL EDUCATION IN THE GOLD COAST.

By W. H. PATTERSON.

*Government Entomologist, Gold Coast.*

AGRICULTURAL education is at the present time entirely under the control of the Agricultural Department, and the scope of work embraces:—

(1) The introduction, propagation, and distribution of plants and seeds of economic products.

(2) Research work relative to yields of crops; plant pests and diseases, and means of controlling the same.

(3) Instructional work, embracing training of pupils to become agricultural staff officers, itinerant instructors, schoolmasters to manage school gardens, and the local agricultural shows.

If the work of the early coastal settlers be left out, educational measures may be stated to have been started in 1888, when His Excellency Sir W. Brandford Griffith, K.C.M.G., the then Governor, wrote: "It was mainly with a view of teaching the natives to cultivate economic plants in a systematic manner for purposes of export that I have contemplated for some time the establishment of an agricultural and botanical farm and garden where valuable plants could be raised and distributed in large numbers to the people in the neighbourhood in the first instance, and afterwards sent further into the country by pupils whom I contemplate taking from the schools when willing to give their attention to industrial pursuits. By their labour and agency, when sufficiently educated for the purpose, additional farms or gardens could be started, and by these means the people generally would become acquainted with the fact that other products than those indigenous to the country had been introduced into it were thriving, and would be remunerative, and thus observing the advantage to be gained by their propagation would be disposed to cultivate them. . . ."

Arrangements were therefore made to start a station at Aburi in 1890 with one European curator and one native clerk, and the expansion is so great that to-day there are eleven European officers and twenty-seven native officers, clerks, and learners, with a cocoa industry, the output of which in 1913 reached 113,239,980 lb., valued at £2,489,218. There are five large stations and two small, or sub-stations, yet such is the growth of the cocoa industry alone that it is most difficult to cope with it adequately; consequently, sanitary conditions on many farms are disappointing and may lead to much future trouble, though it may appear that farmers are depending too much upon cocoa; yet Para rubber is being extensively planted, and coconuts may claim attention in the near future.

Owing to the difficulty experienced in keeping pace with the cocoa industry, the staff has as yet not been sufficiently large to enable original research work to be carried out, but with the erection of an entomological laboratory and provision for the appointment of a mycologist, it is hoped results may be forthcoming in the near future.

The cocoa industry owes its present position largely to the demonstration plots at the older stations, but it is aided to a large extent by European and native travelling instructors. Unfortunately, there are a number of difficulties in the way of obtaining the best results from such instruction, the chief of which being: (1) Lack of sufficient officers; (2) the difficulty of travelling; (3) inability to punish owners of neglected and dangerous farms; (4) shortage of labour to work farms, due to the lack of means of transport save by head loads. This instructional work has been assisted by the distribution of simply written pamphlets in English and the vernacular on the cultivation and preparation of the more important economic crops. One special feature should be mentioned, viz., that demonstrations in pruning, cleaning, preparation of land and crops are given on the farms, at which the chiefs and their followers are expected to attend. The sad part of this work is the impossibility of closely following it up, and it is heavily discounted, as the shortage of officers prevents the same district from being frequently visited. It is hoped this may be shortly overcome. Small model blocks were recently started. These have been placed in the charge of local men who had received some weeks' training in cocoa cultivation, and, provided it is found possible to give these plots frequent supervision, they should serve as demonstrations to the surrounding farms.

To provide future officers, the native staff at the various stations is graded as follows:—

| Office | Salary |
|---|---|
| Learner ... ... ... ... | £25 to £40, by £5 |
| Garden Assistant ... ... ... | £40 to £60, by £5 |
| Second-class Overseer ... .. | £60 to £80, by £5 |
| First-class Overseer ... ... ... | £80 to £100, by £5 |
| Native Travelling Instructor ... | £100 to £150, by £10 |

After the trial of various schemes to obtain suitable learners, it was found necessary to adopt this: That candidates should have passed Standard VI, have a good knowledge of English reading, writing, and arithmetic. Selected candidates are appointed on six months' probation; yet there are so many inducements for educated lads that good material is not readily obtainable. The training covers a period of three years, during which time the pupils are given free quarters. After one year's training they are frequently sent as interpreters with European officers on tour, from which they derive much benefit. The training is essentially practical, and but little time is given to the theoretical side, as these men are expected to be farm workers.

Many garden labourers, after learning improved methods, eventually become cocoa farmers, and their knowledge is thus passed on to their neighbours.

Classes in agriculture for school teachers were started in 1904, and may now be regarded as quite successful, for in 1910 sixty-seven received tuition, and the number of applicants is yearly increasing. The course is divided into two sections: the January and July courses, each occupying three weeks. The students attend at the stations daily for seven hours, and, in addition to a lecture of about one to one and a half hours' duration, they perform all classes of agricultural practical work under the supervision of the Curator. Students other than school teachers may attend these classes—an advantage, as many eventually become farmers. The lectures cover the following ground, and provided the candidates have a good knowledge of English and are of fair intelligence, good should result in the future.

## Class I. January Course.

### *Theoretical Work.*

*Atmosphere.*—Composition: oxygen, nitrogen, and carbonic acid gas, water vapour; properties of each; necessity for the balance being evenly maintained; how this is effected in nature by breathing, transpiration, and decomposition of vegetable and animal matter. Air necessary to life, both animal and vegetable, and necessity for it to reach the roots of plants. Water: its composition, indispensable to plant growth (containing plant foods in solution).

*Plant Growth, General.*—Roots, various forms: tap roots, fibrous roots, tuberous roots, adventitious roots, aerial roots, root-hairs. Functions of roots: support, absorption of water and food materials, store up food, etc. Stems, various forms: upright, woody and herbaceous, climbing and creeping, underground, and modifications.

Structure of Stems: Epidermis, cortex, vascular bundles, pith or hard wood in centre, and the medullary rays, the difference between stems of monocotyledonous and dicotyledonous plants, *e.g.*, coconuts and cocoa, the method by which woody stems become thicker, the functions of stems with special reference to the cambium and vascular tissue (food and water channels), etc.

Leaves: Structure, various forms and modifications adopted in nature to suit certain localities; relation to stem through vascular bundles.

Stomata: Chlorophyll and protoplasm; functions—breathing and manufacture of plant food; transpiration.

Flowers: Structure, sepals, petals, stamens, pistil, ovary, ovules. Fertilization: how brought about, agencies, wind, insects, etc. Seeds: structure; seed coat; embryo; cotyledon; plumule and radicle; albuminous and ex-albuminous; methods of dispersal in nature, wind, water, animal. Structure of fruit, *e.g.*, sandbox, etc.; wings. Conditions necessary for germination: air, moisture, and suitable temperature. Propagation of seeds: conditions necessary in nursery beds, sowing, etc.

Weeds: Definition; injury caused by, to cultivated crops; rob the soil of moisture and available plant food by competing with them: overshading, etc.; importance of preventing multiplication of; methods of eradication.

*Soils.*—Formation confined to disintegration of rocks, vegetable decomposition, and alluvial soils. Classification and physical properties: clay, sand, and humus, deep and shallow soils. Principal chemical constituents of: phosphates, nitrates, potash, sodium, calcium, magnesium, iron, and silica. How soils are exhausted: repeated injudicious cropping, weeds, sun's rays. Methods of improving the physical properties and chemical contents of soils: digging, draining, liming, mulching, manuring, etc.

## *Practical Work.*

Use of various tools, especially digging fork, spade, hoes, rakes, rubber tapping implements, line and tape measures.

Preparation of nursery seed beds, methods of sowing seeds, pricking out and potting seedlings.

Propagation of various plants by cuttings, layering, budding, and grafting; watering, holing, and weeding; pruning and training trees. Conservation of moisture by surface tillage, and mulching and weeding established crops. Digging, lining, holing, and laying off of a plantation of cocoa; making drains; and general principles of method of forming a school garden. The preparation for the market of cocoa, coffee, ginger, copra, and such crops as may be ripe at the time of holding the class. Taught to recognize the more important economic plants and the chief ornamental plants.

## Class II. July Course.

### *Theoretical Work.*

Résumé of the work done in Class I.

Cropping (general): Soils and climatic conditions most suitable for the various economic crops; thus, cocoa, deep, rich soil with sufficient rainfall; cotton, a light loamy soil and a long dry season; sisal hemp, poor soil, and a light rainfall.

Scientific Rotation of Crops: Beneficial results of; soil not exhausted to the same extent; deep-rooted and shallow-rooted plants use a greater area of soil; soil does not get plant sick; importance of leguminous plants in a rotation.

Cultivation of the more important crops, such as rubber, both Para and Funtumia; cocoa, different varieties; maize; ground nuts; cotton; sisal; Mauritius hemp; yams; cassava; method of preparing their products and estimated yields per acre and values per cwt. or ton.

Catch Crops: Meaning and examples of.

Green Manuring: Plants most suitable for.

Useful "bush" plants producing articles for export; oil palm; raphia palm; kola, etc.

Insect Pests: Life-history, general; stages of development; nature of destruction by; stage of development in which most destructive; simple methods of control; precautions against; instances of known attack.

Fungoid Diseases: Brief description; necessity for taking active steps to fight against; precautions to use to prevent them spreading determined by nature of attack, *e.g.*, root disease, isolation; stem and branch disease, cutting off and burning; cocoa pod disease, burning; and other general measures to adopt. Fire the most effective and generally cheapest in the end; spraying with fungicide more of the nature of a prevention than a cure.

The value of school gardens properly managed.

### *Practical Work.*

Résumé of work in previous class, together with:—
Digging and preparation of land.

Sowing seeds and roots in the field at stake and in rows; rubber, cocoa, kola, coffee, cotton, jute, corn, ginger, etc.

Planting out plants at measured distances, such as cocoa, rubber, tobacco, lemon grass.

Tapping rubber trees. Preparation of rubber, lemon grass oil, cinnamon, annatto, fibres. Practical treatment of insect and fungoid diseases, such as "*Sankonuabe*" borers, caterpillars, etc.; cocoa die-back, pod disease, root diseases, etc.; collecting and burning all dead wood, diseased and empty cocoa pods.

Preparation of kerosene emulsion, Bordeaux mixture, together with the use of sprayers and syringes.

Students deriving the greatest apparent benefit from the above syllabus are those who have received tuition in Nature teaching at the Government Training Institution for Teachers. The text-book most suitable for the work has been found to be Watts's "Nature Teaching."

The final source of educational teaching is by agricultural shows, which have proved very popular, but which it has not yet been found practicable to hold more than once annually.

# THE ORGANIZATION OF AGRICULTURAL DEPARTMENTS IN RELATION TO RESEARCH.

## THE ORGANIZATION OF AGRICULTURAL DEPARTMENTS IN RELATION TO RESEARCH WORK.

By Bernard Coventry, C.I.E.

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The organization of agricultural research is a matter of the utmost importance, for on the proper ordination of the various units employed depends the success of the undertaking. It will be futile to engage the services of highly qualified and highly paid scientific experts unless their work is conducted on the basis of a carefully devised system of co-ordination. In the establishment of such a system, the guiding principle should be to grant to each department of science the fullest scope and freedom compatible with due recognition of the governing authority, the limitations of its own sphere of work, and the possibilities of a carefully prepared budget. It should further be recognized that the business of carrying on the work in the various branches, such as agriculture proper, agricultural chemistry, economic botany, plant pathology, and the like is in each case a profession requiring a high education, unusual qualifications, and specialized training on the part of the persons employed. The expert officer of one branch is, therefore, not qualified to undertake the work in another. It must, therefore, be realized that the personal equation is an important factor in the scheme of organization, and that the Department stands or falls in the person of the scientific officer whom it engages. Not all who go through a course of scientific study at the Universities are fitted for research, and special care should, therefore, be taken in the selection of scientific officers. They should be appointed on probation for a time, which should not ordinarily exceed three years. At the end of this time, or before it, the services of an unsuitable probationer should be rigorously dispensed with. If found suitable, he should be confirmed in his appointment. Thereafter, he should be left as much as possible to himself. The initiative in respect of a particular line of work and the method of approaching it should be almost entirely left to him, for individuality and tastes play such an important part that to attempt to bring about research by "order" would lead assuredly to undesirable consequences.

The next point we may consider is that of collaboration. How are the various branches of a department for agricultural research to collaborate and yet maintain that freedom which is predicated as being essential? Were we dealing with the research of a commercial or industrial undertaking, where the purpose was, for example, the improvement in the manufacture of certain definite products, the matter would be simple, for the scientific man would have to subordinate his views and his work to the exigencies of the particular business he was engaged in, and it is not unreasonable to expect that on account of the restrictions put upon him by his agreement and the promptings of common sense he would focus his endeavours on the common objective. In an agricultural department under the State the matter is not so simple. The common goal of raising the level of agricultural practice may be approached by many roads, and it is conceivable for lines of work to be taken up in the various branches of agricultural science without any reference to collaboration. There are two kinds of collaboration: one in which the contribution by one branch of science to another is mere assistance given in an ancillary capacity: as, for example, the economic botanist takes up the improvement of the wheat plant on Mendelian lines. It is certain that he will require, during the course of his investigations, to determine the nitrogen content of his wheats. For this purpose he will seek the aid of the chemist. This is but assistance on a minor or fractional factor, which would not exactly be called collaboration. In another case the soil bacteriologist is working at various bacteria-producing plant foods and plant toxins. He requires the aid of the chemist to determine the nature of the plant foods and the nature of the action of the toxins on vegetable tissues. Here the work, both of the chemist and bacteriologist, is fundamental, and nothing short of a collaboration of both officers is required. This is collaboration in its full sense. If we are to preserve the freedom of the individual, there are only two courses open by which true and amicable collaboration can be brought about. The word "amicable" is used advisedly, for without such a quality collaboration could scarcely deserve the name. One course is for combined work to take place under a private understanding; the other is by arrangement in conference or council of the heads of the scientific branches. The formation of such a council is of the greatest necessity for a scientific body attached to an Agricultural Department. While preserving the freedom of the individual, it throws open the road not only to collaboration of the most approved kind, but it can be used for an exchange of views and as an effective control of the work by the scientific officers themselves, and should, therefore, form an integral part of the general scheme.

We may now proceed to give very briefly the various units required in a scheme of research. We will assume a Central Research Institute fully equipped with up-to-date laboratories and a farm of sufficient size, and with such quality and condition of soil as to render the results and operations on the farm normal. The divisions in the institute representing the various branches of agricultural science and practice would be somewhat as follows: A senior officer of the best qualifications should be appointed at the head of each.

(1) The Agricultural Division, dealing with the practice of agriculture proper, animal husbandry, agricultural engineering, and with economics.

(2) The Chemical Division, dealing with physical, chemical (organic and inorganic), and bio-chemical problems.

(3) The Botanical Division, concerned chiefly with plant improvement.

(4) The Bacteriological Division, dealing with soil and other agricultural bacteria.

(5) The Division of Plant Pathology, fungoid and bacterial.

(6) The Division of Entomology.

(7) The Veterinary Division, which may include research and manufacturing laboratories for the production of sera.

(8) Library, publications, illustrations.

(9) Special crops and industries, for which separate officers should, when necessary, be appointed. In a tropical country these might include special investigations on sugar-cane, cotton, tea, rubber, etc.

At the head of the whole should be appointed a director with a separate office, and this brings us to the consideration of the principles that should guide the selection of the occupant of such an important post. Views on this differ widely. At one extreme we have the view that the director of a scientific institute should himself be a scientific man, so that he can manage and control the work of those under him by the weight of his knowledge and personality. At the other, there are those who hold the opinion that he should not be by profession a scientific man, as he would be apt to be biased in the direction of his own branch to the detriment of the others.

In the opinion of the writer, neither of the extreme views are a suitable guide. It is conceivable that the best man available may be a highly trained scientific man, but it is equally possible that he may not. He would not close the door in either case, but would base the principle of selection more on general qualities for organization and control, coupled with sympathy and general understanding of the work and preparedness to sink his individuality. The opportunities for cheap and startling notoriety gained from the achievements of those under him are great to the director of an Agricultural Research

Institute, and the occasions when a " splash in the pool " has been made to the detriment of good and solid results are not uncommon. The successful director will be one who, while exercising sufficient control and influence to get the various sections of an institute to work peacefully together, relieving them of as much correspondence, account and general administrative work as possible, will at the same time obliterate himself in such a manner that every man under him will feel that he is the master of his own job.

From the creation of the Central Research Institute as described naturally follows the necessity of an organization for expansion and the spread and demonstration of the results of research, for the distribution of seed of improved varieties of crops, and for further experiment in particular localities. The spheres of units for expansion and localized work would have to be defined. In India they are the provinces; in England they would conveniently be the counties. At the head of each unit would be an administrative head or director, and the principles of co-ordination laid down for the organization of a Central Research Institute would apply equally to these units. But local problems and the demonstration of improved methods would be their chief concern, and the staff would have to be chosen to that end. The agricultural expert, as opposed to the strictly scientific man, would be chiefly in request, as it is only through him that the farmer and cultivator can be adequately reached. The appointment of other experts would have to be made according as local problems and local differences require research and experiment to be carried on away from the central body. The work of demonstration and distribution will require a subordinate staff sufficiently numerous to effectually push an improved method; and it is to be observed that this staff should be under the direct control of the professional man concerned with the work. The undertaking of demonstration work under the immediate control of the director, especially in tropical countries, is to be strongly deprecated, unless he himself is expert in the particular work with which he is dealing.

In conclusion, it is to be regretted that time and space forbid the entry into the more minute details of organization, and that it has been necessary to confine these remarks mostly to the enunciation of general principles.

These principles may be summarized as under: —

(1) The creation of an institute, made up of divisions dealing with the various branches of agricultural science and practice, immediately controlled by a highly qualified expert officer in charge of each, the whole being under the general governing control of a director.

(2) Fullest scope and freedom allowed for research work compatible with due recognition of the governing authority, and limited in each branch to its own sphere of work and financial possibilities.

(3) Recognition of the personal equation as a ruling factor in the prosecution of research work, and the undesirability of undue interference, or of attempt to bring about research by "order."

(4) Adequate means for co-operation between experts by private arrangement or through the medium of a council.

(5) Control of the scientific work, as far as possible, by the scientific officers themselves in council.

(6) The director to be selected more for general qualities for organization and control, understanding of the work, and readiness to sink his individuality.

(7) Extension of the work by the erection of local stations for the purpose of demonstration and distribution and the working of local problems.

(8) The appointment of an adequate subordinate staff for this purpose under the direct control of the professional man.

# THE ORGANIZATION OF AGRICULTURAL DEPARTMENTS IN RELATION TO RESEARCH WORK.

By Gerald C. Dudgeon, F.E.S.

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The ever-changing demands of the markets of the world render necessary the frequent introduction of new or improved methods in agricultural practice; and, in order that the new enterprise shall succeed from its commencement, it becomes imperative that the course followed shall be one of precision and in accordance with scientific principles.

The practical agriculturist must certainly continue for the present to be the most important participator in the production of crops, but he cannot have the leisure or sufficient opportunity for the examination and proper determination of the use of natural phenomena upon which the improvement of his practical work may often depend.

The study of the laws of natural or chemical science which may be applied to ensure certain results, or the suggestion of the manner in which they can be adapted advantageously to agriculture, must be left to the specialist; the practical agriculturist finding sufficient occupation in the application of the suggestion to his land or crops. That modern agriculture owes its advancement largely to the labours of research chemists, entomologists, and botanists can scarcely be questioned.

The functions of a Government Department of Agriculture entail the provision of advice, assistance, and protection to the cultivators in the country to enable them to compete successfully with those of other countries. Such a department itself should have no commercial interest in the products of the soil, but should be in a position to supply information on all agricultural questions without prejudice.

In order to do this its efforts must be directed to the collection of information concerning agriculture in other countries, as well as to the conduct of scientific investigations locally. Research work is then eminently marked out for adoption by Government Departments, the proper working of the laboratories of which, in an agricultural country, are almost essential for the progress and welfare of the State.

With regard to the manner in which research work is to be carried on, it becomes a rather more difficult matter with Government control than would be the case with private enterprise. The reason for this is that it is not generally recognized by the critics of a Government administration that much greater latitude should be allowed in research than in other Government work; immediate and tangible results are frequently looked for which cannot be reasonably demanded. For instance, it is extremely difficult, and sometimes even impossible, to lay down precisely the direction in which work will proceed, because, when making experiments, results are frequently obtained, almost at the commencement, which may necessitate a complete alteration of the original plan and distribution of expenses. It is easy to realize what effect such an alteration may exercise upon an administration in which, for the most part, the provisional arrangements, budgetary and otherwise, have been carefully defined in advance for the whole year.

In conjunction with the work to be performed in the laboratories themselves, it is necessary that experiment farms should be available. In a country where climatic or soil conditions vary, it may even be necessary to conduct several in different parts of the country. In very few instances, however, is it imperative that the areas of such farms should be of large size. In countries such as the United States and Egypt it does not appear difficult for Government to obtain land on a short lease (in the latter country for a single crop only if necessary) upon the simple guarantee of a slightly superior monetary return than the average one for a similar crop in the same locality. This arrangement enables all experiments connected with manurial, watering, cultivation, or insecticide trials to be carried out in a number of different localities at a minimum cost. It seems advisable to take this opportunity to digress slightly to refer to the distinction which should be emphasized between pure experiment farms and those intended for demonstration, as this point is frequently overlooked. In the case of the former, the object of which is usually to compare one system of operations with another in order to test superiority and to obtain knowledge for subsequent application, it is obvious that the results may be so different and the inferiority of the specially treated parts may predominate so much over the controls that there may be a monetary loss from the area leased. Experiment farms should never, therefore, be regarded as revenue producing projects. The contrary is the case in respect to demonstration farms, where a complete knowledge is assumed by which improved results may be obtained, provided no unforeseen adverse conditions occur. Demonstration farms must, therefore, be considered as indications of a means of getting a greater return, and should show an increased profit over similar farms in the same vicinity which may be considered as the control areas.

With regard to the staff and organization necessary for agricultural research in a Government Department, these are very largely dependent on the special requirements of the country. It can, however, be laid down that, in general, three scientific branches are necessary, the relative importance of each being dependent upon the local conditions and chief crops of the country.

The minimum superior staff in each of these branches and an indication of their duties are shown below:—

CHEMICAL SECTION.

*Chief Chemist:* Conducting and reporting on manurial experiments; recommendations for the treatment of soils; control and disposal of the correspondence of the Section. Investigation of value of mineral resources as applied to agriculture; improvement of soils.

*Assistant Chemist:* Analyses of soils, insecticides, plants, cattle food, etc. Students should be attached to this Section under the Assistant Chemist.

ENTOMOLOGICAL SECTION.

*Chief Entomologist:* Direction of all experiments with applications of insecticides; fumigation of plantation trees; general campaigns against noxious insects, etc. Proposals for legislation and control of the importation of insect pests on plants and in seeds. Organization of industries and demonstrations with regard to useful insects, such as silkworms, bees, lac insects, etc.

*Assistant Entomologist:* Examination of the life-histories of economic insects, systematic classification, propagation of insect parasites, etc.

*Assistant Entomologist:* Research in connection with insect diseases and methods of insect control. Students in entomology can be attached to the two assistant entomologists.

BOTANICAL SECTION.

*Chief Botanist:* Introduction of new plants and the improvement of existing ones. Correspondence and general direction of the whole section.

*Plant Breeder, Assistant Breeder, Superintendent of Experiment Farms:* Mendelian selection. Investigation into the nature and improvement of economic plants. In Egypt plant breeding is of most importance in the Section, as the work of cotton improvement supersedes all others. In countries where extensive permanent plantations exist of tea, cocoa, coffee, rubber, etc., a plant breeder is also necessary. Students should be attached to this Section.

*Mycologist:* Examination of fungoid diseases of plants; advice with regard to fungicides and co-operation with the Entomological Section in connection with the examination of plants and seeds coming from abroad.

In order that each of the above sections should possess at least one officer whose whole time can, if necessary, be given up uninterruptedly to laboratory research and report, routine work should be distributed as far as possible among the students attached to the Section. For instance, in the Chemical Section ordinary analyses of soils, manures, etc., can be carried out by the advanced students. In the Entomological Section, in a similar manner, insect breeding, section cutting of insects for microscopic examination in connection with diseases and similar work can be done by the students of entomology. The plant breeder's work, which largely consists of the examination of the economic value of the plants he has produced by hybridization and selection, and the collection of detailed information regarding the behaviour of different strains, must be assisted in the field experiments by a practical agriculturist. It is a handicap to the efficiency of his own work if he is obliged to arrange the ordinary work of preparation of the soil and cultivation of the crop which is being experimented with under field conditions. It becomes necessary, therefore, that he should have a farm superintendent working in close cooperation with him, and in such a manner that the proper utilization of his suggestions, etc., may be ensured. Valuable results have doubtless been lost in the endeavour to employ the scientific investigator for the practical application of his theories. The students in the Botanical Section should conduct all the germination and other special tests and assist in the supervision of flower counting and other field operations.

In every country it is important that the occupation of the research agriculturist should be dissociated as far as possible from purely administrative work, although, in order to ensure the best results and to comprehend the requirements of agriculture, the administrative head of the department should be acquainted with scientific agriculture in all its branches.

In conjunction with scientific agricultural work, it is necessary that facilities for the publication of results and recommendations should be supplied. An agricultural journal is a necessity, and should not only act as a means of distributing knowledge, but should serve as a record of progress. It is unnecessary that such a publication should appear at fixed periods; in fact, it is better that it should not be designed to do so, as the limitation of time in the preparation of a contribution may detract from its completeness and consequent value.

A reference library and well-fitted laboratories are two essentials for the proper equipment of a scientific agricultural department, and the compilation of a museum should result from the careful arrangement of the material collected and examined.

In describing the organization of a scientific section, it will be clear that I have had in mind for the most part the requirements of the country in which I recently undertook the organization and formation of an agricultural department. It is only necessary to add that the model indicated is that which has been applied to Egypt, and that certain modifications would be found necessary in every country in accordance with the local conditions. In the main, however, it would probably be found adaptable to many tropical or sub-tropical countries.

## ORGANIZZAZIONE DEI SERVIZI AGRARI IN TRIPOLITANIA.

Per il Professore E. De Cillis.
*Direttore dell'Ufficio Agrario.*

Scoppiata la guerra tra la Turchia e l'Italia, ed iniziata l'occupazione della Libia, mentre ancora duravano le operazioni guerresche, il Governo italiano inviava nella primavera del 1912 una missione di tre tecnici, allo scopo di procedere allo studio del paese dal punto di vista agrologico. Prima che si potessero adottare dei provvedimenti intesi a favorire l'agricoltura e la colonizzazione, era appunto necessario che fossero conosciute con la possibile maggiore esattezza le condizioni di una regione, che fra tutte quelle africane era stata meno esplorata e meno descritta. In seguito agli studi eseguiti dalla missione, una prima relazione veniva presentata al Ministero di agricoltura[1] e pubblicata nello stesso anno.

L'anno successivo, pacificata la Tripolitania in grandissima parte, una seconda missione, formata da un numero molto maggiore di componenti, specialisti nelle varie discipline, fu inviata dal Governo italiano. Essa ebbe campo di visitare tutta la Tripolitania settentrionale, e cioè l'intera regione costiera e la parte marginale dell'altopiano. Anche essa presentò una relazione in due volumi, che venne pubblicata lo stesso anno.[2]

Contemporaneamente la *Società per lo studio della Libia*, costituitasi in Italia, inviava una Commissione propria, che si proponeva a preferenza lo studio agrologico del Gebel, ed anche questa Commissione, compiuto

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[1] Ministero di agricoltura, industria e commercio. "Ricerche e studi agrologici sulla Libia." Vol. 1°, La zona di Tripoli. Bergamo: Arti Grafiche. 1912.

[2] Ministero delle Colonie. La Tripolitania settentrionale. Roma: G. Bertero. 1913.

il suo lavoro, nelle primavera del 1914, pubblicava una relazione propria.[3]

In tal modo gli studi preliminari intorno alle condizioni dell'ambiente fisico, della tecnica e della economica-agraria della regione, ed a quelle sociali della popolazione possono dirsi completi. Ed è notevole il fatto che le tre relazioni s'integrano e si completano, giungendo a risultati comuni, per cui la Tripolitania, nella sua parte più interessante, che è quella settentrionale, la più adatta senza dubbio ad un progresso più o meno rapido nell'agricoltura e ad esser colonizzata da elementi italiani, può dirsi oggi sufficientemente ed esattamente conosciuta.

I risultati ai quali sono giunti i lavori delle tre missioni concordano nel riconoscere che la Tripolitania settentrionale, in gran parte della sua superficie, può essere utilizzata mediante l'incremento della coltura asciutta di essenze arboree (olivo, mandorlo, vite, carrubbo, fico d'india ed altre) ed erbacee (orzo, frumento); in minor parte, mediante la coltivazione irrigua delle più svariate specie di piante dei paesi caldi; e quindi generalmente si presta ad una conveniente colonizzazione per parte di elementi italiani.

Sulle basi di queste conclusioni, che abbiamo molto succintamente trascritte, e sulle proposte formulate dalle tre Commissioni, il Governo italiano ha recentemente istituito in Tripolitania[4] un *Ufficio agrario*, al quale sono stati affidati l'impianto e la direzione di tutti i servizi inerenti all'agricoltura ed alla colonizzazione.[5]

Il programma di organizzazione e di attività, che sarà svolto dall'Ufficio agrario, può riassumersi nelle sue grandi linee, nel modo seguente: —

L'Ufficio agrario verrà distinto in due grandi Sezioni; una amministrativa ed una tecnica. La Sezione amministrativa è destinata ad eseguire lo studio statistico ed economico della Regione; a seguire lo svolgersi della colonizzazione; a proporre ed attuare tutti i provvedi-

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[3] "La Missione Franchetti in Tripolitania (Il Gebel)." Firenze, Milano: Filli Treves. 1914.

[4] Con R. Decreto del 2 Marzo, 1914, No. 169.

[5] In Tripolitania esiste un Ufficio economico, istituito fin dal 1912, per i servizi inerenti all'industria ed al commercio.

menti diretti all'incremento dell'agricoltura locale e della colonizzazione. La Sezione tecnica è essenzialmente scientifica e sperimentale, e si occuperà della soluzione dei problemi d'indole colturale, dal doppio punto di vista tecnico ed economico.

La Sezione amministrativa avrà la sua sede in Tripoli, insieme agli altri uffici di Governo. I servizi posti alla sua dipendenza sono i seguenti: —

1° *Servizio di statistica ed informazioni agrarie.*—Esso sarà diretto ad accertare e seguire metodicamente il movimento economico-agrario della Regione, e svolgerà la sua azione:

(*a*) con la formazione di un *catasto agrario*, per mezzo del censimento dei poderi, delle piantagioni e del bestiame;

(*b*) mediante la compilazione di rapporti periodici sullo andamento delle colture, sulle principali faccende agrarie, sulle previsioni e sul computo finale dei raccolti, sul movimento migratorio del bestiame, sull'oscillazione dei prezzi delle derrate agrarie sopra i mercati locali, sulle domande ed offerte di compra-vendita dei terreni e prezzi relativi, sui fitti e contratti agrari diversi, sulla esportazione ed importazione delle derrate agrarie, ed in generale su tutti i fenomeni economici degni di rilievo;

(*c*) mediante inchieste speciali eseguite nelle varie plaghe e sopra determinati argomenti.

2° *Servizio della colonizzazione.*—Esso svolgerà il suo compito:

(*a*) mediante ricerche dirette sulla disponibilità e qualità dei terreni colonizzabili;

(*b*) con la pubblicazione di guide e monografie illustranti determinate plaghe e determinati tipi di coltura;

(*c*) mediante carteggio informativo diretto, fra l'Ufficio e gli agricoltori italiani o altri enti;

(*d*) mediante consulenza tecnica ed aiuti morali diversi;

(*e*) mediante ricerche sullo sviluppo della colonizzazione libera.

3° *Servizio delle concessioni.*—Esso si occuperà di sperimentare la concessione dei terreni demaniali, applicando tipi contrattuali diversi, sopra poderi diversi per estensione, per sistema di coltura e per amministrazione.

4° *Servizio del Genio rurale.*—Comprenderà gli studi e la esecuzione di opere dirette ad utilizzare le risorse naturali del paese, specialmente dal lato idraulico, ed a mettere alcune plaghe adatte in condizioni di essere facilmente colonizzate.

5° *Servizio dell'agricoltura*, propriamente detto.—Si occuperà dello studio e dell'attuazione di tutti i provvedimenti diretti a favorire l'agricoltura indigena e coloniale; quindi saranno a tale scopo adottati tutti i mezzi acconci a questo fine, quali pubblicazioni, sussidi e premi; distribuzione di semi e piante; prove pubbliche di macchine e delle principali pratiche di coltivazione; impianto di stazioni di profilassi e cura delle malattie delle piante e degli animali; ed infine l'applicazione di provvedimenti d'indole legislativa, diretti ad impedire la retrogradazione del patrimonio fondiario del paese ed a stimolarne l'incremento.

La Sezione tecnica avrà la sua sede centrale all'Ex-Scuola di agricoltura turca, poco distante dalla città di Tripoli (contrada Messri); sopra i vasti terreni demaniali che circondano il caseggiato, e che si presentano di natura diversa (steppa a tipo vario, dune mobili) potranno agevolmente impiantarsi i campi e le aziende sperimentali, destinate allo sviluppo del programma di ricerche tecniche ed economiche, proprio a questa Sezione.

Altri campi ed aziende sperimentali saranno poi man mano impiantati nelle varie regioni, ed i primi impianti avranno luogo a Sabrata, a Zliten ed a Tarhuna.

Questa Sezione comprenderà i seguenti riparti:—

1° *Sperimentazione tecnica*.—Essa comprenderà:

(*a*) Campi sperimentali per le coltivazioni aboree ed erbacee irrigue, e per i vari sistemi di elevazione d'acqua e d'irrigazione;

(*b*) Campi sperimentali per le coltivazioni arboree e erbacee asciutte;

(*c*) Campi sperimentali forestali, diretti specialmente allo studio dei frangiventi e della fissazione delle dune mobili;

(*d*) Stazione zootecnica, diretta allo studio del miglioramento delle razze locali, mediante selezioni ed incroci, ed allo studio delle varie pratiche di allevamento, e specialmente dell'alimentazione.

(*e*) Stazione di meccanica agraria, diretta allo studio delle macchine e del lavoro relativo, specialmente dal punto di vista dell'applicazione dei principi del *dry-farming*.

2° *Sperimentazione economica*.—Essa sarà fatta mediante l'impianto di varie aziende irrigue ed asciutte, ad economia e con sistemi contrattuali diversi, ed all'amministrazione successiva di queste aziende con vari sistemi di conduzione. In tal modo saranno specialmente resi evidenti i rapporti fra i vari fattori della produzione ed i vari capitali investiti, la loro singola ed armonica funzione, gli effetti economici e la retribuzione spettante a ciascuno di essi.

3° *Selezioni ed acclimatazioni*.—Comprenderà lo studio delle razze delle piante coltivate in Tripolitania, allo scopo del loro miglioramento e l'introduzione di specie e di razze coltivate in altri paesi del Nord-Africa e altrove, al fine di sottoporle ad un lavoro di acclimatazione, per provare l'utilità economica della loro introduzione.

4° *Servizio meteorologico-agrario*.—Esso comprenderà 6 osservatori regionali e 16 stazioni termo-udometriche, sparse nei vari punti della Tripolitania, anche i più interni (Sokna, Ghadames, Murzuk) ed un osservatorio centrale, che raccoglierà tutte le osservazioni dai vari uffici e li coordinerà ai fini di uno studio completo della climatologia del paese in rapporto all'agricoltura.

La Sezione sperimentale sarà in rapporto con le istituzioni scientifiche italiane, per quelle ricerche e per lo studio di quei problemi d'indole strettamente scientifica e che potranno agevolmente studiarsi in Italia.

Nel suo primo periodo di attività, il personale dello Ufficio comprenderà: un direttore; due capi servizio; un segretario ed un interprete-traduttore; quattro tecnici; quattro assistenti; quattro capi-coltivatori; oltre il personale amministrativo, tecnico e di servizio inferiori, necessario al normale funzionamento dei vari servizi.

Per lo svolgimento dei diversi rami di attività dello Ufficio agrario, trovasi impostata nel bilancio coloniale, per l'esercizio 1914-15, la somma di Lire 716,000. Essa sarà naturalmente man mano accresciuta negli anni successivi, a misura che l'attività dell'Ufficio andrà accrescendosi ed irradiandosi nelle varie plaghe della Regione.

## ORGANIZATION OF RESEARCH WORK FOR TROPICAL AGRICULTURE.

By Dr. C. J. J. van Hall.

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The importance of scientific research is increasing every year, and tropical countries which possess a well-organized staff of able scientists, devoting themselves to agricultural research work, are reaping important benefits.

Until recently tropical agriculture was wholly based upon empirical rules; planters as well as small proprietors were using methods adopted from their predecessors and their fathers. It gradually became recognized, however, that scientific research was indispensable, and that it could render the same important services to tropical agriculture as it had done already to agriculture in temperate climates. The entomologist was called to the tropics to investigate the life-history of the noxious insects and to find out methods of combating them. The botanist was asked to investigate the plant diseases caused by fungi or bacteria, and to find remedies. The chemist was called in to give his help for manurial experiments, for the analysis of fat and oil-containing plants, and for investigating new methods of preparing various products to improve their quality. The agronomist had to begin his investigations on methods of planting, tillage, and pruning, on new varieties and their practical value, on green manures, cover-crops, and shade trees. The introduction of new plants and varieties became an important field of investigation, and the great importance of plant-breeding, so long neglected in the tropics, was at length recognized. The geologist had to give his help for the classification of soils and for finding new methods for ascertaining their value. The bacteriologist could no longer be dispensed with when a thorough investigation of the character of soils was wanted. On the whole there is at the present time hardly a single branch of science which is not essential to the improvement of tropical agriculture. On the other hand, every effort to improve agricultural methods must be sustained by scientific research, and at the present time almost every planter is convinced that he cannot improve his methods without scientific help.

There is, however, less agreement among the scientific men themselves regarding the method of helping the planter and regarding their position towards the man of practice. Speaking generally, we may say that there are two parties. The one consists of men who, above all, are anxious to do real scientific research work; they understand that they must keep in touch with agriculture, because they are working on behalf of it, but their work is more in the laboratory and in the experiment garden than in the field. The other party comprises those who, above all, are anxious to do practical work and to get practical results; they are well convinced that they must follow scientific lines, but they find more to do in the field than in the laboratory or the experiment garden.

It cannot be said that these two parties have always lived in peace together; often they have been at variance, and there have been more or less vehement discussions as to who was right and who was wrong; the one was sometimes called "very scientific but not practical," and the other "unscientific and superficial."

I think we must be convinced that there is no reason for such an antagonism. Just as well people might fight about the question: Who has done the better work, the man who has grown the wheat, or the other who has made food of it? Indeed, the one cannot do without the other.

And here we are coming to the point. With all research work done on behalf of agriculture it must be fully realized that we are concerned with *applied science*, and that there are two sides to this work: the research of the thing itself and the investigation of its application. They are equally important and scientific, and must be done with the same intelligence and the same application if success is to be assured.

In organizing an Institute for agricultural research work, whether it be part of a Department of Agriculture, an Experiment Station, or any other Institute, the organizer will have to take care that opportunity is afforded for the development of both kinds of work, which we may call, for convenience sake, the laboratory work and the field work.

Every branch of applied science has thus its two sides. In phytopathology the worker in the laboratory has to find out the cause of the plant diseases; he has to study the life of the fungus and its host-plant, its behaviour outside the host-plant in pure cultures, its resistance against different disinfectants and its other characters; he has to make inoculation experiments in the experiment garden on different plants, and to study the influence of different circumstances on the effect of the inoculation. The task of the worker in the field is to study the influence of external conditions, such as planting distance, way of pruning, drainage, soil, etc., and the appearance and spread of the disease; he has to make experiments with different fungicides and to ascertain the best method of fighting the disease; he has to consider the cost of the different remedies and the gain obtained by their use; and he has to test in the field different varieties as to their powers of resistance against disease.

In economic entomology the division of labour is about the same; the laboratory man cultivates the noxious insects and makes a very detailed study of their life in captivity; and he endeavours to import from other countries natural enemies of these insects. The man in the field studies the appearance of the insects in the field, the influence of different methods of cultivation, of crop-rotation, and the value and cost of the application of insecticides and other methods of combating the pest.

In geology the worker in the field makes a "flying survey" of the soils, and notes the natural vegetation and the growth and yield of different crops; he takes samples of these soils and sends them to the laboratory, where the laboratory man makes a petrographic study of the samples and studies their physical and chemical characters.

Little need be said about the research work in the laboratory and the arrangement of the laboratories and the experiment gardens. It should be remembered, however, that the best work does not always issue from the best equipped laboratories; one with the most complete installations and the most refined apparatus takes more time from the scientist than a more simple one, and we must remember what splendid work is often done in primitive laboratories. It seems to me of greater importance to arrange things so that the laboratory man can do his research work undisturbed, without being called upon to perform other duties. Experimental work always takes much time, and good scientific research can only be effected when one can devote himself entirely to it. Therefore, let the laboratory man be troubled as little as possible with administrative work, with educational work, or anything of this kind. Give him his experimental garden close to his laboratory, so that he can walk into it at any moment he chooses, to inspect his breeding plots, his insect house, or his infection experiments. Do not hurry him to get results too soon —research work done in a hurried way is always bad work—but give him an opportunity to go into the questions as thoroughly as he can to obtain results of fundamental importance.

The scientist in the field, whether he be geologist, botanist, entomologist, or chemist, has to work in quite another way. He has to investigate the methods of cultivation and to improve them. His part of the work is to put into practice new methods and to investigate their practical value, the expenses, and yield obtained. It is an error to think that this can be done in an experiment garden; the conditions here are different from those on a plantation or in the field of the small proprietor, and this fact makes it impossible to get in the experiment garden a clear and complete account of any new method, be it the application of a manure, a spraying method, a method of tilling, pruning, or crop rotation.

There are only two ways by which conclusive results may be obtained: either the scientist himself must carry on the experiment on the fields of some large experiment plantation, or he must do it on a plantation in collaboration with the manager of the plantation (or on a field of a small labourer in collaboration with the owner).

The last-mentioned method is to be preferred; it has two great advantages:—

(1) In collaboration with a practical planter or native proprietor, the methods can be investigated thoroughly from a real practical point of view.

(2) For the demonstration and propagation of a successful new method an experiment on a plantation or a field of a small proprietor is much more effective than one carried out in an experiment garden or an experiment plantation.

A few examples may be given in support of this contention:—

Experiments to fight the witch-broom disease of cocoa in Surinam were started in 1904 and 1905 on three plantations in collaboration with the managers. The method applied consisted in removing the entire leaf-bearing crown, followed by spraying—a rather drastic measure, about which most of the planters were very sceptical. After a few years experimenting, however, we knew not only that the method successfully eradicated the disease, but we knew also exactly what expenses for labour, tools, etc., it required, and the practical difficulties the planter had to be prepared to meet when he applied it himself. Further, the neighbours and other planters came to the plantation occasionally to follow the results, and when we were convinced of the success of the method it was unnecessary to begin a campaign for demonstrating, propagating, or advertising the method. This result could never have been obtained so quickly if the experiment had been carried out in an experiment garden.

It is quite true that not every planter and not every small proprietor is fit for such a collaboration, and it is an important part of the task of the scientist in the field to select the right man.

Breeding experiments with cocoa and coffee were commenced two years ago by one of the private experiment stations in Java. The work was started on two cocoa estates and one coffee estate in collaboration with the managers. The botanist drew up a scheme, according to which some thirty trees were selected by the managers on each estate; these were kept under observation by the managers, who noted down particulars as to the appearance of diseases, yield, quality of produce, etc., in accordance with the scheme made. As a result of these observations some of the trees have been eliminated, only the very superior ones being kept. The managers then carried out experiments to surround the selected trees by suitable cages to prevent pollination from neighbouring trees. This year (1914) seed will be collected, and the descendants of each tree will be grown in separate fields, so that the planters, together with the botanist, will be able to form an opinion as to the value of each strain of coffee and cocoa plants. Putting it into a few words: the scheme was made by the botanist, the work was done by the planters, and only occasionally was it necessary for the botanist to visit the plantation to see if the work was going on satisfactorily and to help in eliminating difficulties.

Such experiments are not only valuable for obtaining improved races of coffee and cocoa, but at the same time the planters are educated to become plant breeders.

The advantages of collaboration between the scientist and the practical man have also been proved in the efforts made in Java to improve the cultural methods of the small proprietors.

At first the Government established several "demonstration fields," on which the travelling instructor had different plots, made by his own workmen, to demonstrate new cultural methods or new crops to the Javanese small proprietors. The effect, however, was very poor. Whether the Javanese farmers inspected the demonstration field or not they kept to their old methods. Therefore, another way was tried. The travelling instructor now selects a few of the most intelligent and most forward of the small proprietors, and induces them to apply the new methods or to try the new crops on their fields. If it is a success they adopt the new method, and it is remarkable how quickly the neighbours follow their example.

This general outline will serve to give an idea of the scheme of organization as regards the division of labour in the laboratory and the field, and of the character of these two phases of the work.

There is, however, another matter not less important than the organization of a right division of labour, and that is to ensure a proper collaboration between the two workers.

It need hardly be said that the man in the laboratory must be kept informed as to the results of the field experiments, and often his attention will be called to new objects for investigation. On the other hand, the worker in the field needs the results of the laboratory work in order to organize his experiments on a rational basis. Only by keeping in close touch with each other can they work along the right lines.

Between the different branches of science also a good relationship is necessary. Very often the botanist will have to refer to the geologist, to the chemist, etc., for information and help. Such a collaboration will enable each man to acquire a knowledge of the lines of work of the department or station as a whole, and this knowledge will be of importance to all the scientists. In a very interesting paper, *Circular No. 117 of the Bureau of Plant Industry, U.S. Department of Agriculture* (Washington, 1913), on "The Bureau of Plant Industry, its Function and Efficiency," Mr. Galloway, the Chief of the Bureau, makes this interesting statement: "The future success of the Department" [of Agriculture in the United States] "will depend in large measure on each man being made to feel a personal responsibility as to the details of his work and at the same time realize that he must lend his full support to matters of general policy which concern the division of which he is a member and the department as a whole."

It has often been said that schemes are things not fit to be followed. I am convinced that the sentence quoted is just as applicable to the scheme I put forward here as to others.

In organizing agricultural departments and experiment stations we have to reckon with local conditions, with the funds available, with the scientific men we can get for the work, and with many other conditions which often compel us to arrange things differently from the scheme I propose.

It may be well at this point to mention the conditions obtaining in the Dutch East Indian Colonies.

As regards the estates, several private experiment stations have been established, each being devoted to one or to a few special cultures, like tea, or coffee and rubber, etc. They are situated in the centre of the districts where the particular crops are grown. This makes them very suitable for experimental and demonstration work on the plantations. The staff of scientists, however, is not always large enough to do all the research work as completely as is desirable. On the other hand, the Department of Agriculture can hardly ever be made sufficiently large and extensive to do all the local experimental work in the field. Under the present Director of Agriculture arrangements have been made to ensure as far as possible a proper division of work, and there has been loyal co-operation in this respect, much of the research work being done by the staff of the Department, and much of the field work by the scientists of the stations. In order to keep in close touch with each other combined visits are made frequently to the plantations, and once a year all the scientists of the stations and of the Department meet for a few days to discuss the work and the way of collaborating.

As regards the small labourers, each district has its own agricultural instructor; these instructors have all taken a course of study at the Agricultural High School in Holland, and have passed additional examinations in Buitenzorg. Their duty is to carry out the experiments in collaboration with the native small proprietor; the laboratory work or research work, in the strict sense of the word, is done by the botanists, entomologists, geologists, or chemists of the division to which the subject belongs, be it the investigation of a plant disease, a manurial experiment, or any other investigation. Between the workers in the laboratory and the agricultural instructors frequent interviews are held, and combined visits to the fields are made to fix the work and ensure collaboration.

In other countries different arrangements may have to be made. But whatever the adaptations to special conditions may be, it must always be the aim of the organizer to provide facilities for pure research work in the laboratory and experiment garden, as well as for experimental work in the field. Opportunity must be made to enable the man carrying on research to work as freely as possible, to go very thoroughly into the question, and to make his work as fundamental as possible; no hurrying whatever, simply to obtain practical results quickly, must be allowed. The experimenter in the field must go straight to his object, and for this purpose opportunity must be made for him to work in close collaboration with the planter or native farmer. By this means it will be possible to attain a practical success, and at the same time to demonstrate the new method.

Our endeavours to improve agricultural methods in the tropics must always depend on the united efforts of these two scientists.

# SANITATION AND HYGIENE ON TROPICAL ESTATES.

## NOTES ON TROPICAL HYGIENE AND PLANTATION WORK AND THE ANTI-MALARIAL CAMPAIGN IN THE FEDERATED MALAY STATES.

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AND

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The subject of the problems of tropical hygiene and preventive medicine which arise in plantation work is a large one; to deal with it comprehensively in a short contribution would be impossible, and all that is attempted now is a brief reference to a few of the most interesting and important facts, to experiences which may be of value, and to some general conclusions which have been arrived at in the Federated Malay States. In this country, as in many others, those who control plantations are realizing that good health is absolutely necessary, and that a robust labour force is the great factor in the management of an estate economically. We depend on immigrant labour, which for agricultural purposes is mainly recruited from Southern India. Estates have their reputation to maintain in India, and those places where much sickness prevails find it difficult and expensive to obtain labourers; hence even the engagement of workers is hampered by bad health. Estates with a good reputation not only recruit labour at less expense, but are able to secure more vigorous individuals who, of course, require less medical attention, do more work on each day, and work more days in each month; whereas the unhealthy estate pays a higher recruiting rate, and generally obtains a less satisfactory type of individual, who does less work each day and works fewer days each month. At the same time, to get and keep him a higher rate of pay has frequently to be given: this is in addition to the expense of caring for a large percentage of sick persons. All the foregoing appears so very obvious that it would hardly seem necessary to mention it, yet many of those who are connected with agricultural undertakings are still apparently unconvinced that substantial and permanent prosperity is so very dependent upon good health, and that expenditure on the prevention of sickness is not only humanitarian, but highly productive, sound, and business-like.

Immigrant labour has been immensely valuable in this country, but the introduction of labourers to a tropical area but recently opened up has certain drawbacks, none of which are really insuperable. In the first place, the recruiting of Indian labourers from remote districts, where they have not been living under good hygienic conditions, increases the risk of introducing infectious diseases. Before April, 1911, many estates were put in quarantine every year because new arrivals brought serious illness themselves, or in their clothing. To combat this difficulty a system of detention for seven days on arrival was instituted; this period, added to the five or six days at least spent on board the steamer, has proved sufficient for the detection of anyone incubating illness and to prevent the spread of it amongst the labour forces on estates. The result of the system has been particularly gratifying; since its adoption (with one exception—a delayed incubation case of small-pox) no estate has been infected by new arrivals. When it is stated that over 100,000 persons arrived during the year 1913, and many of them proved to be infected, the advantage of the system needs no further comment. The method is as follows: On arrival of the ship the immigrants are taken to the detention camp and separated into groups, vaccinated, and clothing and persons are disinfected. At the end of a week, if found free from disease, they are distributed to the various estates who have recruited them. A further advantage of the system is that the immigrant has a period of rest after the voyage, and is well fed for a week before commencing work, and as many of them only come because they are poor and possibly on the verge of destitution in India, the benefits of a rest and good food are considerable, and it has been found that all gain weight during their detention in the camp; thus they start work in better physical condition than if they were sent direct to the place of their employment. A Labour Code (No. 6 of 1912) is in force which provides for the protection of the health of labourers.

Protection measures on individual estates will now be discussed, and it is first necessary to mention the dangers a labour force in the tropics is confronted with. The most important are cholera, dysentery, ankylostomiasis, small-pox, and malaria. Cholera, dysentery, and ankylostomiasis can be prevented by attention to water supply and sanitation. When water is obtained from a stream or spring this must be kept uncontaminated, and when obtained from a well, the well should be lined, covered, and fitted with a pump, care being taken that no seepage can find its way into it from the near neighbourhood. Open wells are dangerous: not only can various objectionable matter be thrown into them and dirty vessels be used for lifting water out, but coolies habitually dip their loin cloths into open wells, and this is obviously attended with evil consequences. Drinking water in the tropics is generally warm and particularly suited to the development of disease germs, and the greatest possible care of it will be well repaid. Daily efficient scavenging and the provision of adequate latrine accommodation near the barracks of a labour force will keep down the incidence of dysentery and prevent the spread of ankylostomiasis. If the manager in control of a plantation takes peculiar care of these two necessaries of life—drinking water and scavenging—he will go a long way towards keeping his labour force healthy and fit for work. Small-pox will be prevented by vaccination.

Malaria is undoubtedly one of the greatest scourges in the tropics. It is argued—and there is good reason for accepting the argument—that the movements of peoples in a tropical area increase the virulence of malaria, and apparently people who are but slightly affected in one tropical country become seriously affected when moved to another. Again, it is recorded that increases of population in areas subject to malaria add very largely to the virulence and intensity of the disease. In the Malay States malaria has to be reckoned upon and dealt with by the planter, the haunts of the malaria-carrying mosquito must be obliterated if he is to keep his labour force efficient; in fact, in some cases, if he is to keep a labour force at all. The Federated Malay States Government has instituted a Malaria Advisory Board to investigate the best methods of preventing malaria and to show how these can be carried out, and the Executive Engineer attached to the Board will, in the latter part of this paper, describe and discuss the work done.

Finally, attention is called to the Annual Reports of the Principal Medical Officer, Federated Malay States, for 1911 and 1912. It will be seen from these that the death-rate amongst estate labourers has fallen enormously. The figures for 1913 are 29 per 1,000, as against 60 per 1,000 in 1911. This reduced mortality is largely due to protection of water supplies, better housing, better sanitation, anti-malarial measures, and last, but not least, more individual attention to the labourer, and especially to his food. To argue that all a planter needs to do is to see that a labourer gets a little rice, and expect good health and good work as a consequence is foolish. Rice alone is not sufficient; even if enough rice is eaten to supply the amount of energy required for an ordinary day's work, the bulk of that amount is not and cannot be digested. Male labourers are not as a rule efficient cooks, and are often careless about their cooking; they are also addicted to the habit of cooking a supply for more than one day, so that what is kept over from the first day becomes sour and unwholesome. Attention to the food supply of a labour force is essential; this has been widely recognized here, and the good results of such attention are very obvious wherever it has been given. Some who are expert in the management of their labourers supply cooked rations without finding difficulties. This is the best way. Others see that proper meals are cooked and consumed. Whatever system is carried out it should be part of the manager's duty to attend to this, and in no case will it fail to benefit the labourer and increase the returns to the estate from the labour force.

These few notes are hurriedly put together in the hope that our experiences may be useful to those engaged in plantation work in the tropics. Effort has been made to use the simplest language and avoid technical terms, and only a few of the most important points have been mentioned; but if these few points are recognized and adequately dealt with by the planter, many costly evils can be definitely prevented.

As mentioned earlier in this paper, malaria is one of the greatest scourges of the tropics, and it is particularly severe in the Malay States. With the growth of the planting industry and the consequent introduction of Tamil labour from Southern India, the effects of malaria became so marked as to call for special activity on the part of Government. Death-rates on some very malarious estates rose at times to as much as 500 and 600 per 1,000 per annum. Government insisted through the Health Department on many expensive sanitary reforms and general measures, and these, as stated, have been successful in reducing abnormally high death-rates, but have had less marked effect on malarial sickness.

On the flat lands near the coast agricultural improvement of the land, coupled with the housing of coolies some distance from undrained jungle, as persistently advocated by Dr. Watson and others, had the desired result of practically abolishing malaria, but in the hill-lands these measures produced no results, and the reason for this will appear later. Towns situated in hill-land have also suffered severely, and from time to time various measures have been tried without much benefit. This was not in most cases due to the wrong advice of medical officers, but to the lack of thoroughness in carrying their advice to a logical conclusion, and a few years ago the attitude of authority was to view malaria as an unfortunate but unavoidable evil in hill-land.

Kuala Lumpur, the capital of the Federated Malay States, suffered in common with all other similarly situated towns, and the death-rate from malaria for the five years 1907 to 1911 averaged 9·56 per 1,000 per annum. As a large number of officials live in the town, and these were continually attacked by malaria, their complaints were sufficient to cause Government to take action. The splendid results obtained from the anti-malarial campaign on the Isthmus of Panama showed that thorough work properly directed was capable of effecting the desired improvement. Kuala Lumpur has a population of about 50,000 inhabitants, there are some swamps situated along the banks of the rivers, but the principal breeding places of malaria-carrying mosquitoes were found to be in the ravines among the hills surrounding the town. Apart from these places the town was fairly well drained. In 1908 funds were provided to enable the Public Works Department to attempt thorough drainage as an anti-malarial measure in the ravines. The work proceeded in a desultory fashion until 1911 without success, and in that year Government, at the instance of the Principal Medical Officer, appointed a Malaria Advisory Board to control and direct measures to be taken against malaria throughout the Federated Malay States.

In addition to various general decisions the Board decided, first, completely and thoroughly to drain a section of Kuala Lumpur, which was typical of malarious hill-land, and which could serve as an example. The work was rapidly carried out, and by the end of 1911 a large area of Kuala Lumpur had been thoroughly drained. The work was continued, and at the end of 1913 an area of about 3,100 acres, including almost the whole of the hill-land, had been drained. The swamps are now being dealt with, and by the end of the current year (1914) work on all these should at least be well in hand.

Before discussing the results of the work it will be as well to understand what are the requirements of anti-malarial drainage. Malaria is carried by certain varieties of anopheline mosquitoes. Mosquitoes will not breed in running water; hence if all water in any district flows with a fair velocity in channels free from obstruction, mosquitoes cannot continue to exist in that district. Owing to careless wording in the writings of some authorities, an idea is prevalent that certain mosquitoes can breed in running water. To disabuse the mind of this incorrect notion, it is only necessary to remember that mosquito larvæ are for two or three days at least quite helpless, or nearly so. Mosquitoes breed in the pools formed along streams and among the weeds and algæ of their margins; and it is owing to the way pools are formed along hill-streams and ordinary earth drains in hill country owing to violent flooding during rains, that hill-land drained to a certain standard for agriculture yet remains a breeding ground for mosquitoes, and hence is often malarious. In addition, hill-land is full of springs which are constantly breaking out in fresh places.

To drain hill-land thoroughly it was necessary to use agricultural pipe drains, although their use was attended by great difficulty, and, it may be remarked, that except in the case of work carried out under the Malaria Advisory Board, often resulted in much expense, and at least partial failure. A description of the work cannot be given here, but it is hoped that an exposition of the methods employed will shortly be available. It may be stated, however, that complete success has attended the work of the Board, and that the most precipitous country has been drained at a very moderate cost, and that thorough drainage can now be employed with confidence on any ground by those properly qualified to undertake it.

The results of the work in Kuala Lumpur are most satisfactory, and demonstrate in a striking manner the advantage of anti-malarial drainage well carried out. Unfortunately, the returns are still effected by the continued existence of four large swamps, known to breed anopheline mosquitoes, where filling work is in progress under the Public Works Department, and what malarial sickness remains in the town is largely due to these swamps. The table below gives the true death-rate and the malarial death-rate for each year since 1907:—

| | 1907 | 1908 | 1909 | 1910 | 1911 | 1912 | 1913 |
|---|---|---|---|---|---|---|---|
| True death-rate per 1,000 ... | 37·9 | 43·7 | 32·3 | 30·3 | 39·4 | 36·7 | 35·5 |
| Malarial death-rate per 1,000 ... | 9·7 | 10·7 | 7·7 | 9·8 | 9·9 | 5·8 | 4·2 |

Malaria does not, as a rule, prove fatal, except after many attacks, and the reduction in the malarial death-rate means an enormous reduction in malarial sickness. In a town situated as Kuala Lumpur the "true" death-rate will always be higher than the "real," as only one month's residence is needed for a person to be classed as a resident, and there will always be a significant death-rate from malaria while it exists on the borders of the town, but malaria can and will be practically eradicated from Kuala Lumpur.

Further interesting figures are available in the health returns of the Police Depôt, Kuala Lumpur, for the years 1910 to 1913 inclusive Sikh and Pathan police recruits are trained for a few months only at the depôt, so that the population constantly changes, and conditions are, therefore, favourable to severe malaria. The following table gives the average monthly percentage of Indian recruits at the depôt who were detained in hospital or given sick leave for malaria monthly:—

| | 1910 | 1911 | 1912 | 1913 |
|---|---|---|---|---|
| Average monthly percentage ... | 35·8 ... | 57·0 ... | 27·3 ... | 11·3 |

The protective works here were practically completed early in 1912, except for the continued existence of one of the swamps mentioned above, which still affects the health of the depôt and the town in the neighbourhood. Very few places can show a sickness-rate to compare with that given for 1911 above, when on an average every Indian recruit was attacked by malaria seven times in the year. Owing to the great improvement in the health conditions all recruits suffering from malaria are now admitted to hospital. Formerly there were too many cases to allow of this being done.

Amongst the Government Officers and their servants, who live in a completely drained area, few cases of malaria have occurred since the beginning of 1912, and none of these have been reported by the medical authorities as having been infected or reinfected in the area itself. Formerly these officers suffered severely.

That the improvement in the malarious condition of Kuala Lumpur has been due to the works undertaken is proved by the persistence of malaria in the neighbourhood of the swamps already referred to, and also on the limits of the drained area. Several new bungalows on the north-west of the original area were occupied early in 1913, and nearly all the occupants were attacked by malaria. Since the middle of the year, when drainage work in the neighbourhood (commenced in January) afforded definite protection, no new cases have occurred. Temporary quarters were built for 200 Tamil coolies on the western limit of the drained area early in 1913. The Tamil coolies, who had not had malaria for the previous year or two, were attacked so severely that they had to be removed back within the drained area, with immediate improvement. An attempt to house Chinese coolies in the quarters had similar results, and the quarters have been abandoned. Rubber estate coolies to the south of the drained area suffered from malaria, and the estate authorities have, during the past few months, carried out a thorough drainage scheme to protect them, with the assistance of the executive officers to the Board.

The experience and the results obtained from the work in Kuala Lumpur are very convincing, and anti-malarial drainage on similar lines is to be applied to all the malarious towns in the Federated Malay States.

The executive officers of the Malaria Advisory Board have also supervised anti-malarial drainage work on many other estates, and it may be mentioned that their services are available to private authorities without charge, upon request. In order to have definitely conclusive proof to offer to estate owners of the good and economy to be derived from anti-malarial drainage, the executive staff are now carrying out a demonstration scheme on a very malarious estate, where everything that ordinary sanitation and medical practice can suggest, short of mosquito destruction and mechanical protection, has already been tried without success. Full particulars of the work on this estate and the health returns will be made public from time to time.

Dr. C. A. Bently remarked at Madras in 1912 that drainage and jungle clearing, in order to eradicate malaria effectively, must be accompanied by extension and improvement in agriculture. By this he undoubtedly meant that such works were not likely to remain effective unless extension and improvement of agriculture formed part of the general scheme; in other words, that subsequent maintenance of anti-malarial works was of equal importance to their proper execution. Provision must be made for maintenance at the time when the works are provided for.

Whatever arguments are put forward for the good to be derived from any particular measures affecting health, they are not likely to be productive of action on the lines advocated, unless it can be shown conclusively that such measures will result in a sufficient return to those who undertake them. It is not anticipated that the fact that proper and thorough drainage will eradicate malaria will be disputed, as the point was proved many times even before the method by which the disease is transmitted was established. The object of this portion of the paper is to show that sufficient knowledge has been gained for a definite statement to be made as to the cost of eradicating malaria in the Federated Malay States, and hence in other similarly situated countries. The original cost of thoroughly draining hill-land in the Malay States, unless it possesses quite exceptional features, will not exceed $36 (£4 4s.) per acre of gross area drained, and will generally be much less. (The rates of wages for labourers are: Tamils—35 cents—about 10d., and Chinese—about 65 cents—about 1s. 6d. per day.) Thorough drainage in hill towns will cost, as a rule, a little more than this, as many features have to be included which should really form part of ordinary town drainage, and more attention must be paid to appearance. The cost of maintenance may be accepted as about 10 per cent. of the first cost in the year following construction, and 5 per cent. in subsequent years; these are the maximum normal figures, but it must be remembered that undesirable saving in expenditure on construction will most certainly lead to heavier charges for maintenance, and also that maintenance should commence on the day that construction ceases.

It is at present considered necessary to drain all land thoroughly within a distance of half a mile of a dense population, although a less distance will give adequate protection to a scattered population, and local circumstances must be considered in this connection. From the rate per acre given above the approximate cost of an anti-malarial drainage scheme in any locality can easily be obtained by those having a full knowledge of local conditions. A close estimate of the cost of any particular works can only be prepared by an engineer who has had experience of the work required. One point needs special consideration in any scheme for thorough drainage as an anti-malarial measure, and that is, whether it is better to concentrate the population it is desired to protect or to protect it in a scattered condition. There can be no doubt that at least partial concentration is economical, and the cost, if any, of moving buildings on this account should be added to the cost of the drainage scheme to obtain the total cost. No difficulty can attach to concentration of population either in a town or on most agricultural estates, but further experience is needed before a pronouncement can be made in connection with areas under rice cultivation and other similar areas.

Against the expenditure on thorough drainage has to be set the great improvement to health conditions which will undoubtedly follow, and in particular on estates, in which this Congress is interested, the greater working capacity of the labour force, the greater efficiency of the labour force consequent on better management resulting from more active supervision on the part of a healthy manager and assistants, reduction in recruiting expenses due to improved reputation, and reduction in medical administration charges. The greater working capacity and efficiency of the labour force following improved health conditions will usually be the most important, although there are many estates in the Malay States where the reduction in medical administration charges alone, if malaria were eliminated, would pay for a thorough drainage scheme in about three years, and these are by no means the worst cases. The difference in cost of labour per unit of output from a well and a badly managed labour force can easily amount to 50 per cent. or more, especially when the force works for day wages. On a malarious estate in Selangor, having a manager and six assistants, there have been occasions when only one has not been confined to his quarters with malaria. Efficient management is impossible under such conditions.

In conclusion, it may be remarked that anti-malarial measures require to be carried out with a thoroughness which can only be appreciated by those connected with the work, and no anti-malarial measure is likely to succeed unless it is under the immediate supervision of a responsible and competent officer who is keenly interested in its success. Medical officers can effect little as regards thorough drainage without the co-operation of engineers, and it rests with them, therefore, not only to initiate action on this problem, but also to interest the engineers who will be connected with its solution. This can rarely be accomplished in any way other than by personal effort. It should be borne in mind also that failure in the demonstration of measures calculated to improve health has a most serious effect on public opinion and the mind of authority, and it is on this account far better when endeavouring to carry out such an economical improvement as the eradication of malaria to make sure of it being thoroughly well done in one locality, when the rest can safely be left to public opinion and authority, rather than to risk the possibility of failure by inadequate work in many localities. Reduction of malarial sickness follows good thorough drainage so quickly that there is no fear of the public neglecting to couple the cause with the improvement.

# AGRICULTURAL CREDIT BANKS AND CO-OPERATIVE SOCIETIES.

## AGRICULTURAL CREDIT BANKS AND CO-OPERATIVE SOCIETIES.

By Sir James Douie, K.C.S.I.

*Late Financial Commissioner in the Punjab.*

The decade from 1840 to 1850 was a very noteworthy one in the history of co-operation. It saw the start of co-operative distribution in England and co-cperative credit in Germany, both of which have since grown to vast dimensions. History should assign very high places among the makers of modern Germany to Raiffeisen and Schulze, the authors of the two main types of co-operative credit societies. Indeed, their influence has spread far beyond the limits of the German Empire. I must assume in my hearers a general knowledge of the wonderful growth of co-operative credit in Europe. It is enough to note that there are now 17,000 banks of the Raiffeisen type, pure or modified, in Germany, four-fifths of which are united in an Imperial Federation, which also embraces about 8,000 other co-operative societies, 41 unions, and 77 central societies. A few years ago the membership of credit societies affiliated to this great federation amounted to 1,200,000 persons, and their working capital was £106,000,000, of which £102,000,000 consisted of deposits, while loans granted during the year amounted to 15½ millions, and payments on current accounts to 33½ millions.

I cannot better describe the pure Raiffeisen type of bank than by setting out the constitution of the village banks affiliated to the Irish Agricultural Organization Society.

(*a*) Limitation of area, so that all members may be acquainted with each other.

(*b*) Persons known to be sober, honest, and hard-working eligible for membership. Poverty no bar.

(*c*) No entrance fees or shares.

(*d*) Members jointly and severally responsible for repayment of all sums lent to or deposited in the bank.

(*e*) Deposits bearing interest received from members and outsiders.

(*f*) Loans made only to members and only for productive and economical purposes.

(*g*) Period of loan sufficiently long to admit of its object being attained before repayment is demanded.

(*h*) The borrower must produce two sureties.

(*j*) No division of profits. They must be credited to a reserve fund.

(*k*) Complete equality of members, the officials being elected at a general meeting.

(*l*) No payments to officers, an exception being sometimes made in the case of the Secretary. Raiffeisen was in favour of combining credit and trading functions in a single society, and this combination is often a feature of German rural banks.

The Schulze Delitzsch type of bank is very different. Large areas are preferred. Shares, which nowadays are often pretty large, are held by the members, dividends are paid, and the percentage which may be allowed as the return to shareholders is not limited. Since the German law permitted limited liability the Schulze Delitzsch banks have mostly adopted it. Loans are, as a rule, granted for short periods. Service is not gratuitous. These banks, therefore, approach far more closely to the ordinary business bank, and there is always a risk of their becoming commercial undertakings pure and simple. They are not poor men's banks in the sense that Raiffeisen banks are. There is no reason why a farmer should not be a shareholder in a Schulze Delitzsch bank, and in Germany many farmers are. But the Raiffeisen bank meets far more fully the needs of the small peasant landholder, and to-day we may confine attention almost entirely to pure or modified examples of that type. Since 1889 shares have by law become a necessary feature of co-operative credit in Germany, but most Raffeisen banks have kept their shares quite small and have clung to unlimited liability. Where limited liability has been adopted it bears a very different meaning from the term as used in England. It is deliberately arranged that shareholders shall only pay up a fraction, sometimes but a small fraction, of the nominal value of their shares, while their liability extends to the amount of such nominal value. Some of the Raiffeisen banks which followed the leadership of Herr Haas showed at one time a very undesirable tendency to rely on State aid. There is one feature of Raiffeisen banks on which their founder laid the greatest stress, and which figures prominently in the articles of the 4,000 banks included in the Raiffeisen Federation. It is declared that "the society rests upon a Christian and patriotic foundation," and among its objects is "the organization of means for the promotion of rural social welfare and love of home." It is this feature of Raiffeisenism which has specially appealed to the clergy, and one result has been the organization of a large number of successful rural banks in Italy which are really branches of the Roman Church organization, and whose members must be professed Catholics. Raiffeisen societies are run by popularly elected committees of management and boards of supervision. The function of the latter is to scrutinize the executive work of the former and prevent imprudence or abuse. A further check has been provided by the grouping of the rural banks in unions, with power to inspect and audit the accounts of all affiliated co-operative agricultural societies. For the purpose of financing rural banks central banks have been formed, the shares in which are held by agricultural co-operative societies. German rural banks as a whole have succeeded in attracting sufficient deposits to supply their wants in the way of loanable capital. One rural bank receives more than it requires and another less. The former could lend direct to the latter, but it is far more convenient for both parties that its surplus should be deposited in a central bank, and thence distributed to the bank whose loans exceed its deposits.

There is no time to speak of rural banks in other

European countries. In connection with the problem of indebtedness in India and tropical countries the case of Servia is, however, specially interesting. In that land of small peasant farmers usury was rampant, and its exactions so monstrous that the extreme step was taken of forbidding sales and mortgages without the consent of the authorities. At the close of 1908 Servia had over 800 village banks of the pure Raiffeisen type, liability being unlimited, and all profits being carried to the reserve fund. I shall have a word to say before I close of the uplifting effect of these village banks on the Servian peasantry.

The lessons to be learned from European experience are that, where we are dealing with small peasant farmers the Raiffeisen type is the best. The absolutely essential points are limitation of area, the rigorous exclusion of unworthy members, the grant of loans only for productive or economical purposes and on the production of proper security, the enforcement of punctuality in repayment, and a thoroughly democratic organization. The question of shares or no shares, of limited or unlimited liability, of dividends or no dividends, are matters to be decided according to local circumstances. If there are dividends the maximum rate payable should be fixed, the figure should be moderate, and it should be a *sine qua non* that a considerable part of the annual profits should be carried to reserve. Where loans have to be taken by the bank it should establish a pretty wide margin between the rate it charges to members and the rate it pays. Personal security is best. Securities consisting of mortgages are dangerous because realization may be difficult and the turnover tends to become too slow. Eleemosynary loans of State money should be ruled out. Governments easily succumb to the temptation to bribe one class at the expense of another, and, whatever the result to the giver, the taker is not blessed. State loans, if given at all, should bear a rate of interest which protects the general taxpayer from loss. Even so they are only justifiable as a temporary expedient. Their tendency is to make banks careless and to turn them aside from their real object of creating credit out of thrift.

The Government which finances rural banks will sooner or later claim an amount of control over them which will rob them of much of their power for good. The question whether a single society should be concerned with credit and with trade is one regarding which there is much difference of opinion. Except in the case of very small societies, I think the attempt to combine the two functions is inconvenient, if not dangerous.

The problem which presents itself in Eastern and tropical countries is not identical with the European problem, because of the different character of the people at their present stage of development and the comparative absence of ordinary banking facilities. It is fortunate, therefore, that we have now eight years' experience of the successful working of rural banks in the different provinces of our Indian Empire, much of which is included in the tropics. It must also be remembered that in some of our tropical Crown Colonies East Indians are now an important element in the population. My own Indian experience was gathered from a long residence in the Punjab, and part of what I have to say has special reference to the state of things existing in that province.

The Indian population is predominantly rural, being engaged either in tillage or in crafts ancillary to tillage. As a rule, land is cultivated in small parcels by peasant farmers, who are either tenants or owners. An ordinary holding in the Punjab, a land of small proprietors, is one of 6 or 7 acres.

If the British Government did not create ownership in Northern India, it certainly made what was previously worth little a very valuable possession. It made titles secure by drawing up a complete record of rights, and it gave the landowner a substantial share in the profits of farming by limiting its demand for land revenue and assessing it for comparatively long terms. Finally, it established the *pax Britannica*. The result was a rapid extension of cultivation and a rise in the value of land, which to-day on the average sells in the Punjab at over a hundred times the land revenue. But the very success of the policy created a new problem. Ignorant peasants, hard-working but rarely thrifty, and on certain occasions, *e.g.*, at marriages, almost compulsorily extravagant, found they had become possessed of what was for their position in life large credit. They used it foolishly, and once a man was on the books of the local usurer he found himself on a slope, at the bottom of which was a slough of despond consisting of a practically irredeemable mortgage of his holding. Fourteen years ago the Government took its courage in its hands and put severe restrictions on alienations of land to persons not belonging to agricultural tribes.

For many years the Indian Government has offered loans for agricultural improvements at a rate of interest sufficient to secure itself against risk of loss. The usual rate is 6¼ per cent. Such State loans are known as *takávi.* They are secured by the mortgage to Government of a sufficient part of the borrower's holdings. The periods allowed for recovery are ample. Large powers are taken to enforce repayment; but it is only in the rarest instances that resort to them is necessary, and *takávi* is generally recovered with ease and regularity. The amount advanced in the Punjab in a recent year was £22,000. Contrast this with the sum of £414,000 lent to members by credit societies in 1912-13.

The first Indian Act relating to Co-operative Credit Societies was passed in 1904. It was superseded in 1912 by an Act dealing with co-operative societies of all kinds having for their object "the promotion of the economical interests" of their members. It follows orthodox lines, but no attempt has been made to force into one mould societies spread over a vast territory inhabited by 300 millions of people of the most diverse creeds, characters, and social conditions. Here it is only necessary to notice one or two points affecting village agricultural credit societies. Societies are to consist of ten or more persons residing in the same town or village above the age of 18. The liability of the members is unlimited unless the Local Government otherwise directs. Loans may not be given on the security of movables without the sanction of the Registrar, and the Local Government is empowered to forbid or restrict loans secured by mortgages of real property: 25 per cent. of the profits must be credited to reserve, and 10 per cent. may be devoted to charity. Government can prescribe a maximum rate of dividend on shares by rule. Societies, of course, can themselves provide for this in their by-laws. The most important thing to notice is the powers of audit, inspection, and control which the Government reserves. An annual audit must be made by the Registrar or under his orders. The audit must include an examination of overdue debts. The Registrar may carry out an inquiry into the state of any society of his own motion, and must do so on the demand of three-fourths of the members. If a creditor requests him to have the books inspected he must comply. If the result of the inquiry shows that it is necessary he can order the winding up of the society.

I have only time to give you a few figures to illustrate the marvellous growth of agricultural co-operative credit in India in the eight years following the passing of the Act of 1904. In 1905-06 there were 283 banks with a membership of 28,629; in 1912-13, 12,324, with a membership of 573,536. The increase during the last year in the number of societies amounted to 50 per cent. The capital rose from £31,548 to £3,562,286. The distribution of the latter sum is interesting:—

| | Per cent. |
|---|---|
| Loans from other societies ... ... ... ... | 36¼ |
| Loans (mostly deposits) from individuals ... ... | 25 |
| Deposits of members ... ... ... ... | 17½ |
| Share capital ... ... ... ... ... | 16⅛ |
| Reserve ... ... ... ... ... ... | 3 |
| Loans from Government ... ... ... ... | 2⅛ |

The loans made were in 1905-06, £22,696, and in 1912-13, £1,920,712. The most remarkable advance has been in the Punjab, where the energy of the peasants, and the fact that they own their own holdings, has supplied an excellent field for co-operation. In Burma an interesting development is the starting of a number of insurance societies.

The organization of the societies varies a good deal in different provinces. In Northern India the Bengal societies are nearest to the original Raiffeisen type. The Punjabi wanted shares and the prospect of future profit. The shares, valued at 10 rupees (or 13s. 4d.) each, are subscribed by instalments extending over ten years. In old banks, after ten years, members can withdraw fully paid-up shares, but they cannot withdraw their quota of the profit earned, which is allotted to them in fresh shares. No dividends are payable for ten years, and it will be necessary to fix a maximum that may be given thereafter if grave risk is to be avoided. In new societies the shares are not withdrawable, and it is to be hoped that the older societies will agree to modify their by-laws as regards this matter. It may be interesting to note the objects for which loans were granted in the Punjab in 1912-13:—

| | Per cent. |
|---|---|
| Purchase of cattle | 26½ |
| Payment of old debts | 18 |
| Payment of Government revenue | 12 |
| Household expenses | 11 |
| Fodder for cattle | 10 |
| Marriage expenses | 7 |
| Seed | 5 |
| Redemption of mortgages | 1 |
| Sinking of wells | 1 |
| Other purposes | 8½ |

The figures refer to number of loans granted. Nearly half the money advanced was for paying off old debts and redeeming mortgages. There are some signs in the Punjab that unpunctuality in repayment of loans by members may cause trouble. The Registrar has noted that "more care must be taken in admitting members and in making loans, and better security must be required." In the last resort it is always possible to order the winding up of a society that will not reform. Another danger, or rather, the same danger in another form, is the too ready renewal of loans or the grant of a new loan immediately after an old one has been nominally paid off. The village banks have been largely grouped in unions, and a number of central banks have also been formed. These societies are on the basis of limited liability. Most unions in India undertake not only the duty of promoting common action and providing inspection, but also that of financing the affiliated banks. The ordinary joint stock banks have begun to show their confidence in the co-operative central banks and unions and to supply them with funds when required. The most usual rate of interest paid by central banks on deposits is 6 per cent., and the most usual rate charged on advances to village banks 9 per cent. The latter pay from 6 to 9 per cent. to depositors, and usually lend at $9\frac{3}{8}$ and $12\frac{1}{2}$ per cent. I ought to have said that shares in co-operative central banks in the Punjab are largely subscribed by private individuals.

Fortunately, the Government has from the outset been chary in the matter of lending to societies. I have already noted how small a portion of the working capital is now represented by State money. In the Punjab it is less than 1 per cent. I think most people who know the East well will agree in thinking that as regards audit, inspection, and control, the attitude of the Government in India must for some years to come be very different from that which is befitting in Europe. I shall quote one or two remarks on this subject made by two Indian gentlemen at the yearly Conference of Registrars in 1912. Rai Bahadur Bishn Datta Shukul said: "If we ask our depositors and shareholders why they believe co-operative business to be sound, they invariably show that they attach tremendous importance to audit by the Registrar and his staff. . . . I speak for the public of the Central Provinces when I say that the co-operative movement will fail altogether unless Government continues to supply a special audit staff." Rai Bahadur N. R. Kelker, who also belongs to the Central Provinces, said: "Western theories and Western practice must be modified to suit the requirements of the case. It will take years of hard, continuous, and patient labour, both on the part of officials and non-officials . . . before we can hope to see an organization independent of Government control and supervision. The possibilities of abuses and waste due to ignorance, if not to anything else, have to be avoided at any cost. . . . If Government control is abruptly withdrawn at this stage . . . the movement as a whole will wither away. . . . Once the idea gets abroad that 'independence' is contemplated people will lose all confidence." Recent exposures of fraudulent marriage funds and joint stock banks in India have probably confirmed these two gentlemen in their views on this subject. In the Punjaub the controlling staff paid by Government consists of an English Registrar and Indian Assistant Registrar, seven inspectors and ten sub-inspectors; but unions and central banks pay for an additional inspecting staff, which also works under the orders of the Registrar. The enthusiasm displayed by some of the carefully chosen body of inspectors is most hopeful. They are not red-tape bureaucrats, but sometimes, on the contrary, deserve to be described as missionaries of co-operation.

British Colonies and Dependencies are broadly divisible into countries in which people of European descent can do field work efficiently, and countries in which farm labour must be done by indigenous or imported coloured people. Tropical countries and a considerable area north and south of the tropics fall into the latter category. The difference is reflected in the form of administration. In the one class we have the self-governing Colonies, and in the other the Crown Colonies and our great Indian Dependency, where popular Government is impossible. So far as agricultural credit banks are concerned attention may be confined to the coloured population, indigenous or imported. It is unlikely that under present circumstances co-operative credit will appeal to farmers of European descent in our Colonies, or European landowners, too often absentee, in the West Indies. Apart from the ordinary business sources of credit they will rely on State loans. The agricultural loans of Rhodesia, Australia, and New Zealand are identical in their nature with *takávi* in India. In democratically governed countries any system of State loans may lead to abuse, and this at least is essential, that they should be made at such a rate of interest as will safeguard the general taxpayer from loss.

In this matter of agricultural co-operative credit in the tropics we have at present to think of three classes: —

(*a*) East Indians.

(*b*) Other Asiatics, as Cingalese, Malays, and Polynesians.

(*c*) Persons of pure or mixed African descent.

Experience in India itself leads us to conclude that the first class, especially where it has the opportunity of acquiring land, is excellent material for co-operative credit. The East Indian comes from a country whose people are familiar with communal village life and the action of caste and trade guilds. It is worth while, therefore, to take a rapid survey of the position of East Indians in our Crown Colonies. Ceylon has about one million Indian immigrants and their descendants. The agricultural credit movement has already spread from India. It should be of use to the East Indians, and probably also to the native Cingalese. In the Malay States the native is not disposed for regular field work, and there is a steady inflow of Indian labour. Here, too, there should be room for co-operative credit societies, at least among the immigrants. In Fiji the Indian element is growing rapidly, and is likely to become the predominant one, for the unenergetic indigenous population is unfortunately dwindling. The natives of that fertile but thinly populated group of islands evince no desire for a strenuous life, and I fear we may leave them out of account. When the African slaves were freed, the first use they made of their liberty was to refuse regular work, and the planters had to look elsewhere. Mauritius began to import Indian labour eighty years ago. By 1907 the population had increased fourfold. It numbered 376,000, of whom 264,000 were of East Indian descent. The rest are mostly Creoles. The neighbouring French Colony of Réunion has also a considerable Indian population. Turning to the New World, British Guiana has a population of 300,000 (only three per square mile), of whom 133,000 are East Indians. The future prosperity of the Colony largely depends on this element. Dutch Güiana has also a considerable Indian population. Trinidad, with 800,000 cultivable acres, nearly half of which is Crown property, had twenty years ago 70,000 East Indians out of a total of 200,000. Creole labour is abundant in Jamaica, and there the East Indian element is smaller and much less essential, though still useful. British Honduras could profitably absorb much East Indian labour. I think we may say that wherever in our tropical possessions the East Indian has settled under fair conditions there is hope for the development of co-operative credit.

Regarding persons of African descent, I do not speak with any first-hand knowledge. In their own continent I fancy Africans are usually accustomed to a communal frame of society and also prefer to work in gangs, each having its own leader: they, therefore, possess some of the requirements of co-operation. But at their present stage of development most of them must be hardly fitted for the working of self-governing societies such as we are accustomed to in Europe, and with modifications in India. Some of you may be interested in knowing how the Roman Catholic Church met the difficulty among the aborigines of the Chota Nagpur division in India. The information is to be found on p. 14 of the Report of the Fifth Annual Conference of Indian Registrars. Even in the West Indies people of African descent are obviously not as good material for co-operative credit as East Indians. They require a strong spur to make them regular workers: but they can respond to it, as in Barbados, where it is provided by pressure on the soil. Elsewhere it may be hoped that the example of the East Indians, and the chances now offered by the policy of land settlement, will give the needed stimulus.

Of late years two closely connected questions of land settlement and co-operative agricultural credit have been much discussed in the West Indies. Fortunately, discussion has now ripened into action. As regards both matters, St. Vincent has taken the lead among the islands. In 1911 it started its first agricultural credit society. Last year it passed an Ordinance for "registration, encouragement, and assistance of agricultural credit societies under the 'Raiffeisen System.'" The Raiffeisen model has been closely followed even in the prominence given to religion. Government, I think wisely, has reserved strong powers of inspection and control. Where the treasurer is not a minister of religion or a justice of the peace, he must be "some respectable and responsible person approved by the Governor." The latter can instruct a public auditor to investigate and report to him regarding the organization and administration of business, and he can at any time cancel the registration of a society. Arrangements have been made, and no doubt will in future be made, for a more sympathetic kind of inspection than that of an auditor. There were, some time ago, six societies in St. Vincent with 123 members, all probably small farmers. There is some difficulty in securing the rejection of unworthy candidates for membership, and for some time this will require careful watching. The Government lent the six societies £294 at 6 per cent., but I believe the administrator has been able to arrange with a joint stock bank which will get rid of State subventions, a very temporary expedient. British Guiana and Trinidad, where the field of action may ultimately be vastly larger, is moving in the same direction. The British Guiana Committee, which reported in January, 1911, rejected unlimited liability, contemplated small local banks, not exclusively agricultural, taking advances from Government at 4 per cent., and making loans to their own members at 12 per cent. Four per cent. seems much too low a rate for the State to charge, and financial aid from Government should only be looked on as a temporary expedient. How long it is likely to be required a person unacquainted with local conditions cannot judge. I believe this report has recently been discussed in the local Legislature, but I have not seen a report of the proceedings. Jamaica has a number of rural societies financed by the State, and not of the pure Raiffeisen type.

While the State should limit its financial assistance, both in respect of time and amount, as far as possible, I suppose that it will have to assume at least as much share in the direction and control of the movement as we have found necessary in India. There is one point in this connection which is not really unimportant, and that is the avoidance of requiring needlessly elaborate accounts and returns. I look with dismay at the lengthy annual statement required in England from every little village bank, with its petty receipts and disbursements. A hard-worked, half-educated, and unpaid secretary sometimes gives up the task in despair. Educational work intended to teach the benefits of co-operation and the means whereby they can be secured is a thing on which State money and the time of Government officials may very properly be expended.

I have in the main left you to infer from figures the economic benefits which co-operative credit societies have diffused. People do not make use of village banks to the extent they do in Germany or India, unless they meet a very real and very pressing need. And I have been silent regarding the moral benefits to which Raiffeisen attached equal importance. But, in conclusion, I may make one quotation from a Servian report, translated by Mr. Wolff, on p. 483 of his book on "People's Banks." "Peasants who used to spend their days in the public-house playing cards and boozing have thrown off that habit. . . . On one occasion a member of a village bank was seen playing cards and losing 4 francs. He was brought before the Committee and summarily expelled. Other members who were suspected of indulging in play took warning, and are now rarely to be seen in the public-house. . . . The annual report of the village bank of Azagna says: 'Our Association has taught us to respect one another and to help one another, to enable each to live better and to work better. In a little time it has made us learn many useful things which our schools have failed to teach us.'"

*O si sic omnes!*

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## THE WORKING OF CREDIT BANKS IN THE NETHERLAND EAST INDIES.

By H. CARPENTIER ALTING, Batavia.

THE object of the system of popular credit banks is to give the inhabitants, and more especially the native population, an opportunity to save money, and, in the form of loans against interest, to obtain material assistance for carrying on their trade and occupations, for the acquisition of estate, and for other useful purposes. It is in principle intended also for persons other than natives, and therefore generally supplements the work of the great European banks.

The primary purpose of such banks is to furnish the population with the necessary means, at a reasonable rate of interest, for carrying on their business or vocation and for other material purposes, and to cause such means to be contributed *as much as possible* by the people themselves. A natural outcome of the latter is that a regular and economical production of goods as well as their proper distribution and use are encouraged.

Since 1904 the system of popular credit banks has been under the care of the Government. Previous to this, however, popular institutions already existed in certain places. These were generally of the nature of provident institutions, viz.:—

(*a*) Loan and savings banks for natives (Government officials and private persons), such as the so-called "prijaji banks."

(*b*) Mutual burial and benefit funds.

(*c*) Village barns for the mutual storage of selected rice seed ("loemboeng bibit").

(*d*) Village barns for the supply of rice (padi) to indigent persons, either on loan or free ("loemboeng miskin," or "loemboeng amal").

(*e*) Societies for defraying the cost of ritual feasts given by the members, more especially marriages and circumcisions ("sinoman" societies). On the island of Bali village banks are found which lend money to the villagers.

The origin of these various institutions is uncertain; but it is known, however, that as far back as the beginning of the nineteenth century the Government took an interest in the storing of rice (padi) in the villages, with a view to assisting the necessitous and ensuring a supply of seed, whilst Dutch officials introduced, or at least encouraged, the idea of making monetary provisions, more especially for the benefit of native Government employees.

The popular credit banks which have been organized since 1904 and systematically established on those already existing are closely connected with the system of government in native communities, regencies, or provinces, divisions and districts. They fall into three categories: —

(1) *The Village Rice Credit Banks.*—These are known as "loemboeng dessa" in Java, and "loemboeng negari" on the West Coast of Sumatra. They are institutions of the native community (in Java "dessa," on the West Coast of Sumatra "negari"), or of groups of native communities, and therefore of the village communities. The stock of rice (padi) is usually formed by the farmers from contributions *in natura,* which are returned later on out of the profits earned. Less frequently the original stock is obtained from joint planting by the dessa members on a portion of the communal land.

Where the means of the population appear to be insufficient the Government advance money, free of interest, for the purchase of padi and materials for cultivation. The padi is lent out on condition of repayment *in natura* when the next crop comes in, with an additional 25 to 50 per cent. by way of interest. As soon as the debts due in respect of the loemboeng have been paid and a reserve fund has been formed, the interest is reduced as far as practicable according to the loss due to the desiccation of the padi and the cost of administration.

In law the loemboeng is regarded as a property and a trade of the native community, established at the expense of the farmers.

The necessary buildings are erected by the joint labour of the dessa people. The padi which has not been loaned is sold annually, and out of the proceeds the expenses of administration and the cost of repairs to the buildings are defrayed, the balance being paid into a reserve fund. The reserve funds of the loemboengs dessa are invested in current account at the local people's bank (divisional bank). The final result, therefore, is that the native community possesses a building free from debt, with a stock of padi as well as a reserve fund in cash. Loans are principally given to farmers at the time when field work is carried on. The management of the loemboeng is in the hands of a committee, which usually consists of three farmers and the chief of the village, who receive a share of the profits. The book-keeping is in charge of a competent person, who is in the service of, and paid by, a group or circle of neighbouring villages, and who visits the various loemboengs in turn according to a fixed table (once a week).

The dessa loemboeng is generally found in those villages where the cultivation of padi is the principal means of subsistence. It prevents the padi crop passing too quickly out of the hands of the farmers into those of the purchasers, and thereby obviates a rapid fall in price during and shortly after the gathering of the crop, and a strong rise a few months later when the padi is in the buyers' hands. The price of the padi is, therefore, more uniform during the year, a circumstance which has a favourable influence on the feeding of the people and on their wages. The loemboeng further enables the farmer, without having to suffer want, to give better and more timely attention to the tilling of the soil.

Where the land is owned by a large number of small proprietors there is less justification for the existence of the loemboeng. This is generally true also of those places where the local supply of padi is insufficient to provide the necessary food, necessitating its being imported, and where, therefore, the population has to adopt other means of support (commercial crops, industries, fisheries, etc.). The constant improvement in the means of intercourse, both inland and with foreign countries, also diminishes the need of padi credit. The turnover of the loemboeng in Java has, in fact, reached its highest point; the money bank is gradually taking its place.

The arrangements and management of the loemboeng are subject to regulations fixed by the community concerned and approved by the authorities.

The loemboeng miskin and loemboeng bibit which still exist at some places are gradually diminishing in number.

The dessa loemboengs, both district and divisional banks, have established a mutual fund for insurance against fire and other calamities.

(2) *The Village Money Credit Bank* (village, dessa, negari, or marga bank).—This is a savings and credit bank for the benefit of the inhabitants of one or more hamlets, villages, or groups of villages. It has the same legal standing as the loemboeng dessa, and is governed and managed in the same manner.

In Java the working capital is usually formed by means of a loan obtained from the divisional bank by employing the moneys of the loemboengs or those belonging to the native community. The borrowers, however, are obliged to pay, in addition to the capital sum and interest, a surplus which is booked as a deposit on their part. The interest charged is fairly high, 24 to 40 per cent. per annum, but as only small sums are lent (usually not more than 10 fl. (1 florin = 1s. 8d.) to any one person) this interest is not oppressive. Repayment is made as a rule in weekly or monthly instalments, *e.g.*, if 10 fl. be borrowed, 11 fl. must be repaid in eleven weeks; this includes 1 fl. for interest and deposit. This arrangement has the advantage that, as the bank builds up a capital of its own out of the profits, a smaller amount is booked as interest and a relatively larger amount as deposit. The deposits are occasionally returned in part, *e.g.*, on fast days or on other important days. The high interest enables the bank soon to repay the capital taken up. In some places part of the deposits is retained and converted into shares of from 1 fl. to 5 fl. Only such persons are admitted as borrowers as shall be first accepted by those already affiliated. Their identity is established by means of finger prints. Although legally,

therefore, a communal institution, the dessa bank assumes more or less a co-operative character. Outside Java it is easier to make the people themselves contribute at once the initial capital, in the form of shares of one or more guilders. As soon as the working capital amounts to a sufficient sum and a reserve has been formed the interest is reduced. The banks here referred to have a current account with the divisional or residency bank (see below) for the borrowing of working capital or for temporarily depositing surplus funds. The village banks, which so far have lent chiefly small sums of a few guilders per head, will gradually become the ordinary credit and savings banks of the small farmers, traders, and artisans. This is especially the case in a thickly populated island like Java, where the means of the great mass of the people are insignificant.
type of bank has developed out of the mutual savings and credit bank of native Government employees (so-called

(3) *The Regency, Divisional, or District Bank.*—This prijaji bank). The latter began by lending its surplus funds to farmers and artisans, but has gradually assumed the character of a *general savings and credit institution,* chiefly accessible to the individual natives and the village banks. The opportunity offered to invest money is also taken advantage of by non-natives and by the native communities. The area served by the bank often coincides with an Administrative Department, seldom with part thereof; in the outer Colonies, sometimes with a whole District, having a population of from a quarter to one million. Such a bank, which has often many branches, is under the management of an incorporated association of notables, official and non-official Europeans, and natives (Article 1653 of the Civil Code of the Netherland East Indies). This association is of a purely philanthropic character, and the members are not allowed to benefit financially.

The institution is in some places called a *regency,* in others a *divisional* or *district* bank (generally popular bank).

The administrators perform their duties gratuitously; nevertheless, the bank is managed on strictly commercial principles, and is therefore not a charitable institution. It is intended to appoint gradually representatives of the depositors and creditors on the managing body, but at present Government officials and other prominent inhabitants predominate. The management is carried on by a responsible administrator (usually a European), assisted by European and native book-keepers, clerks, and other members of the staff. The Government assists the banks as long as is necessary with cash subsidies to defray the expenses of management; in 1913 such subsidies amounted to 127,000 fl. In the first few years after 1904 loans were also given by the Government to the banks out of the Government exchequer at the rate of 4 per cent. interest with a view to the formation or supplementing of the working capital; there was no obligation to pay the interest, but this had to be added to the reserve fund until such time as such additions should appear to be no longer required. Since January 1, 1913, when the Central Fund (see below) commenced operations, the Government has ceased to furnish working capital, except for supporting through the medium of the banks measures of an economic nature, involving special risk, and for which the Central Fund has no money at its disposal, such as the importation of foreign breeding cattle, the colonization of Javanese in the outer possessions, etc. The banks do not possess any capital of their own other than the reserves formed, with the exception of two, who have a small share capital. It is therefore their object to form a strong reserve fund as quickly as possible.

The working capital consists of deposits made by individuals and by native communities and local societies. such deposits are principally: —

(*a*) Deposits at from three to twelve months' notice of repayment at a rate of interest varying from 4 to 6 per cent. per annum; these deposits are chiefly made by Europeans.

(*b*) Savings, which may be withdrawn on demand at a rate of interest varying from 3 to 4 per cent. per annum.

(*c*) Compulsory deposits at a rate of interest of 6 per cent. per annum, *i.e.*, money which borrowers bind themselves to deposit, and which are only returned in urgent cases or when borrowers completely sever their relations with the bank.

(*d*) Moneys in current account from village credit banks, from native communities, and from public institutions at a rate of interest varying from 2 to 6 per cent. per annum.

(*e*) Borrowed moneys.

The banks lend money chiefly for productive purposes to individuals, to companies, and other associations principally of native producers or consumers, and to native communal credit banks for the benefit of agricultural pursuits, trade, and sea fisheries, as well as for the redemption of mortgaged lands and crops, and the preparation of ground for cultivation. Money is also lent for the erection of dwellings and on a moderate scale for non-productive purposes.

The banks encourage in this way production in every field of labour and enterprise in which the native is engaged or which are open to him. The interest charged by the banks amounts to from 12 to 18 per cent., exceptionally 24 per cent. The banks have also commenced to act as intermediaries in cash transactions between the natives by the issue of drafts, cheques, and the opening of current accounts, thus supplementing the work of the large European banks.

As security the banks demand a personal surety or, especially in the case of small farmers, joint sureties ("tanggoeng renteng" or "tanggoeng menanggoeng") consisting of small groups of borrowers. The latter measure also tends to promote mutual confidence and supervision as a basis of social responsibility and co-operation. The banks have further been declared competent to establish a credit charge on hereditary individual and undivided substantial rights of natives in respect of grounds belonging to the State domain, and also on existing or proposed buildings, works, and plantations of natives on land on which native rights of usage are in force (*Netherland East Indies Government Gazette*, 1908, No. 542). This credit charge is in its nature identical with a mortgage, but is so far not accessible to individuals. (See also *Netherland East Indies Government Gazette*, 1909, No. 584.) The credit charge is especially a means of counteracting the custom very prevalent amongst natives of mortgaging grounds and fruit trees, such mortgaging giving the creditor the usufruct of the mortgaged property and thereby impoverishing the debtor.

Property on which a credit charge has been established continues to be used by the debtor, who therefore enjoys the revenue thereof. It is consequently provided that any mortgage on property on which a credit charge has already been given shall be void.

A credit charge is given by an authentic Act (in conformity with a fixed form), executed before a native Government official. The Act is entered in a public register. The cost is a very small one.

Should it be necessary to levy execution on any property on which a credit charge has been established, the same will be carried out through the medium of the President of the Native Court of Law.

The banks also enjoy exemption from or reduction of stamp duty in respect of share certificates in the working capital (*vide* the stamp ordinance). The banks issue annual printed reports.

(4) There also exists at Batavia a central bank under the name of Central Fund for the Popular Credit Banks, with which the credit banks referred to under (3) may enter into connection. This body has been established by Royal decree (see *Netherland East Indies Government Gazette*, 1912, No. 393), is incorporated, and provided by the Government with a working capital, which will be gradually increased to 5,000,000 fl.

The objects of the Central Fund are:—

(*a*) To supply working capital to and investing the moneys of popular credit banks, and (*b*) to advise and assist in their management.

The Central Fund is also of service in the supervision of such banks, carried out on behalf of the Government (see below, "Government Supervision"). It has power to contract loans, to invest its funds in bonds, and deposit same with banking institutions and to purchase movable and real estate in so far as it shall be required for the service of the Fund.

The manager of the Fund is subordinate to the Director of Inland Government, and is under the supervision of a committee appointed by the Governor-General. The staff of the Fund is composed of officials and functionaries in the service of the State, but they are paid by the Central Fund.

The Central Fund renders accountant's services to the popular banks. It pays to the State on the working capital interest equal to that which is paid by the District (now ranging from 3 to 16 per cent.). It charges the popular banks 6 per cent. interest. Credits are only opened to those popular banks which are well managed, and is therefore a guarantee also for the prompt repayment of withdrawn deposits.

The Central Fund may also be charged by the Government with the book-keeping of and supervision as regards the use of funds granted by the Government on behalf of the revival of popular welfare (such as famine funds, etc.).

ABBREVIATED BALANCE SHEET OF THE CENTRAL FUND ON DECEMBER 31, 1913.

| *Debit.* | | *Credit.* | |
|---|---|---|---|
| Cash in hand ... ... | fl. 365·81 | Working capital ... | fl. 2,125,250·00 |
| Banks and banking institutions ... | 368,110·35 | Creditors ... | 156,547·23 |
| Investments ... ... | 1,127,569·10 | | |
| Shares ... ... | 764,008·05 | | |
| Debtors ... ... | 13,594·70 | | |
| Inventory ... ... | 1,100·00 | | |
| Balance of loss ... | 7,049·22 | | |
| | fl. 2,281,797·23 | | fl. 2,281,797·23 |

PROFIT AND LOSS ACCOUNT.

| *Debit.* | | *Credit.* | |
|---|---|---|---|
| Charges ... ... | fl. 41,346·07 | Accountancy ... | fl. 8,970·00 |
| Interest ... ... | 60,645·44 | Interest ... ... | 84,396·22 |
| | | Sundries ... ... | 1,576·07 |
| | | Balance loss ... ... | 7,049·22 |
| | fl. 101,991·51 | | fl. 101,991·51 |

The following figures show the position of the popular credit banks on December 31, 1913:—

(1) LOEMBOENG DESSA OR LOEMBOENGS NEGARI.

| | | | |
|---|---|---|---|
| Java and Madoera : | | | |
| Number ... ... | ... 12,282 | | |
| Assets ... ... | 2,661,000 piculs padi | ... | fl. 2,988,000 in cash |
| Liabilities ... | 218,000 ,, ,, | ... | 902,000 ,, |

(2) DESSA OR NEGARI BANKS.

| | Number | Assets | Liabilities |
|---|---|---|---|
| Java and Madoera ... | 1,300 ... | fl. 800,000 ... | fl. 418,000 (including deposits fl. 227,000) |
| Outer possessions ... | 406 .. | 112,000 ... | 109,000 (deposits) |

(3) REGENCY, DEPARTMENTAL, OR RESIDENCY BANKS.

| | Number | ASSETS | LIABILITIES | | | | |
|---|---|---|---|---|---|---|---|
| | | Money outstanding and in hand, together with the value of buildings and appurtenances | Due to the Government | Due to the Central Fund | Deposits | Other deposits | Reserve funds |
| Java and Madoera | 74 | fl. 15,768,000 | fl. 25,000 | fl. 872,000 | fl.8,716,000 | fl.4,728,000 | fl. 1,427,000 |
| Outer possessions | 6 | 1,128,000 | 47,000 | 249,000 | 249,000 | 139,000 | 49,000 |

*Co-operative Credit Banks.* — Contrary to what is found in most other countries, the popular credit banks in the Netherland East Indies, as will appear from the foregoing, do not emanate from co-operative societies direct, although those interested in these do contribute to the formation of working capital and have a voice in the native communal banking institutions. All banks, in fact, are in a more or less considerable degree under the influence, and even under the direct orders, of the State and village authorities, although it is intended gradually to curtail such interference and render it finally superfluous. The reason why the popular credit bank system has not at once been founded and built up on a purely co-operative basis is the necessity on the part of the superior authorities of improving without delay the need of credit and the periodically recurring condition amongst small farmers of scarcity of food and of means of cultivation, an evil to which attention was drawn more especially in the dry, and for agriculture so disastrous years 1901 and 1902. In the first place, therefore, dessa loemboengs and divisional banks were established in Java on a large scale, followed later on, when the distress had been met, by the establishment at a slower rate of small banks in and outside Java. The Government also made direct grants in the above-named years of money and padi stocks on a large scale where most required, but this system could not be permanently adopted, as it encouraged carelessness, and did not offer sufficient guarantee that the funds were efficiently and honestly applied; no permanent improvement could be effected in this way. The degree of popular development and the sense of social responsibility were not and are not even now sufficient to permit of the establishment of purely co-operative credit banks otherwise than with the greatest caution and by taking steps towards the introduction of co-operative principles in the existing banks. Indeed, in every part of the world the utmost care is necessary in establishing the co-operative movement on a firm basis. In the life of the natives primitive forms of association are not uncommon (see above), a fact which, as regards small farmers, is scarcely surprising. In money matters, however, there is little or no mutual confidence, all the less on account of the feudal power of the head of the family, hamlet, or village, keeping the voice of the ordinary man in the background.

Only the more emancipated, the officials, and privately employed persons possess sufficient elements for the establishment and maintenance of mutual help societies, which, however, confine themselves chiefly to purposes of consumption or provision at death. As far as the mutual help and savings banks of native officials in Java are concerned (prijaji banks), the majority of these have failed through mismanagement or have been amalgamated with the divisional bank. Only two are still in existence. In the Government of the West Coast of Sumatra such banks are known under the name of "bankangkoe."

Of late years, however, with the rise of the third estate, a tendency has been more and more noticeable amongst the people of forming a common fund with the object of trading for profit and for the accommodation of its members. Most of these efforts have hitherto ended in failure, as an attempt was usually made to attract too many persons. People were included who did not understand the true meaning of such a fund, and who had not complete trust in each other, who were in reality only looking for gain without taking into account the chances of loss, and who failed to realize that everyone must begin by appreciating his citizenship and by showing that he does so. Efforts have been made sporadically to promote a community of interests by the establishment of a fish auction, by planting for joint account, and selling tea and other produce. Here also those interested have so far shown an insufficient sense of devoting and asserting themselves, expecting everything from the organizers. Slowly, however, the people are beginning to understand, and the more emancipated are endeavouring by co-operation and mutual furtherance of their material interests to emulate and get level with the non-native, especially by the establishment of trading and land exploitation concerns, as well as of credit associations.

This tendency is recognized by the Government, and it is contemplated to introduce a legal ordinance relating to co-operative societies, the existing Acts not being sufficiently applicable.

### Official Staff for the Organization, Promotion, and Government Supervision of the Popular Credit Bank System.

Whilst the establishment of popular credit institutions is locally under the care and guidance of the European and native administrative officials and the village chiefs, lower native Government functionaries (mantris) are entrusted with the regular supervision of the existing communal credit institutions and with assisting in establishing new ones; on an average there is one mantri to fifty institutions. The mantris are under the control of European and native officials, who superintend part of a district or one or more districts, and who also, accordingly as required by the organization and as the institutions become capable of managing their own affairs, relieve the administrative officials of their daily labours, even though the system remains under the superintendence of the District Government.

The above-mentioned officials further assist native traders and contractors in organizing firms and in arranging and carrying on a simple system of book-keeping in their affairs.

A general Government adviser in connection with the Department of Inland Administration resides at Batavia, and is charged with the superintendence and further extension of the organization, assisted by a small staff of officials and by the Central Fund.

The bureau of the adviser draws up the working plan, gives hints, distributes guide books, compiles statistics, issues a general annual report, and likewise makes all proposals of a legal and administrative character in connection with its object.

The salaries and duties of the officials and functionaries and their relations towards the administrative officials have been regulated by the Government in official and supplementary gazettes and circulars (see further the *Netherland Indies Government Almanac*, vol. i).

The co-operative system also forms part of the work of these officials, whilst those connected with the Department of Agriculture, Commerce, and Industry are likewise interested in the co-operative system as a means of improving the production.

*Official Publications.*—Periodicals: The reports on the popular credit bank system, at first called "Systematic Review of the Agricultural Credit System," 1904 to 1913 inclusive; ditto the reports of the divisional banks; also a paper distributed by the Central Fund concerning credit and co-operative systems (see also the Colonial report, and as regards the nominative list of popular banks, vol. ii of the Government Almanac).

Pamphlets and other publications in so far as they are compiled by the officials connected with the popular credit banks:—

(1) Hints concerning the establishment, arrangement, management, and supervision of village credit banks (loemboengs dessa and dessa banks) ... ... ... ... 1906, 1908

(2) Arrangement and working method of local savings and credit banks, chiefly for the benefit of the native population (so-called divisional banks) ... ... ... ... 1907
(3) Banking and bank control ... ... ... 1910
(4) Regulations concerning credit banks and their application with explanatory notes (in Dutch and Malay) ... ... ... ... ... 1910
(5) Provisional guide to the establishment of mutual savings and loan banks for natives, more especially in the outer possessions (bank negari) ... ... ... ... ... 1911
(6) Sketch of a method of book-keeping for trade and industries of natives (in Malay) ... ... 1913
(7) Concerning saving; promoting credit banks and mutual co-operation ... ... ... 1912
Dari hal ketjermatan, perhoetangan (credit banks) dan persoekoetoean (Malay translation) ... ... ... ... ... ... 1913
(8) Some particulars concerning divisional banks, compiled by the officials of the popular credit banks in the Netherland East Indies ... 1912
(9) Minutes of the meeting held at Magelang in March, 1913, of the officials for the establishment of the popular credit banks stationed in Java and Modoera ... ... ... ... 1913
(10) Co-operation of natives ... ... ... ... 1911
(11) Transactions of natives for joint account ... 1911
(12) The future arrangement of the Indian credit banks ... ... ... ... ... ... 1910
(13) The fishermen's society at Tegal ... ... 1913
(14) Collection of some decrees and circulars ... 1914

### The Attitude of the Native Population towards the Popular Credit Banks.

An opinion is current amongst non-natives that the native as a rule is unable to save and is extravagant, but this opinion is not founded on just observations and judgments. The native farmer strives, like any other human being, to get something which he can call his own: land, cattle, dwelling, or padi. The ordinary native, however, still often acts in a different way in regard to money as to other property, because money is in many respects looked upon by him less as a means of exchange than as a possession itself, or as a means of purchasing unnecessary articles, and he has not yet learnt to make a judicious use of it.

As money, however, becomes more generally a means of exchange amongst natives, and many articles which are or have become indispensable can now only be obtained with money the native begins better to realize its value, and therefore appreciates more and more its possession. A want of social feeling, fear of theft, or of the demands of embarrassed members of his family and of those in power have certainly contributed to render him careless with money and at first to undervalue its possession, but as it got more appreciated these circumstances induced him to convert the money into easily pledgeable ornaments, or to keep it in a place known only to himself. The popular banks and the post office savings bank have gradually altered this, and more especially the system of compulsory saving.

The native would deposit much more money in the savings and other banks if this could be kept absolutely secret. In many cases, when in want of money, the natives would rather contract a loan than ask for the return of their savings.

The result achieved by the village banks and loemboengs has proved to the native that he need not immediately spend his earnings without injury to his pocket, and that gradually a community of property can be established.

Both institutions have rendered the ordinary man more free in his movements by keeping him more out of the hands of moneylenders, who try to secure for themselves the produce, ground, or labour of the debtors. These moneylenders cannot be blamed. It is necessary for them to be able to rely absolutely on a regular supply of labour and produce and to have the agricultural land at their disposal. As long as the native, not being in want, did not feel impelled himself to provide for these things without the pressure of the advance received on them, the non-native had to take the matter in hand.

Indeed, the system of advancing money, which is decidedly open to abuse as a means of extortion, although this is not the rule, aims in the first place at the above object rather than at putting out money at interest. The credit banks, therefore, strongly co-operate in rendering the people, whose requirements have increased with the pressure of the times, economically free, a first condition to enable them to devote themselves undisturbed to cultivation, to develop enterprise, and to compete in the economic struggle. The native, in fact, begins more and more to raise himself and to engage in trade, industry, and agriculture on a large scale, in which the divisional banks render assistance. The idea is also under consideration of introducing a Bill of limited scope for the prevention of usury, i.e., usury in the sense of extortion, profiting by anyone's pecuniary embarrassment.

Not all moneys, of course, lent by the banks have found useful employment. On the one hand loans have often been granted for measures which, being of too wide a scope, have in the long run proved, although well intended, to have been lacking in usefulness; and, on the other hand, the debtor has often misused the money borrowed. Here and there, for instance, encouragement has been given artificially to the breeding of cattle, the cultivation of certain crops, and the redemption of mortgaged lands, notwithstanding that the need thereof was not actively felt by those interested. As a consequence the debtor has undoubtedly often gone back instead of forward, but gradually, thanks to experience, a more rational comprehension has prevailed, and the native has learnt to take a better view of his social duties.

In the Mohammedan world the interest prohibition of the Koran restrains the strongly religious from feeling the necessary sympathy for the popular banks, which, however, does not prevent the great mass from paying and receiving interest. Neither are the spiritual leaders unanimously opposed to it now that it appears that the interest paid serves to form a reserve fund for the banks, and the depositors also run the risk, at all events in theory, of participating in the losses.

# LEGISLATION AGAINST PLANT DISEASES AND PESTS.

## THE PHYTOPATHOLOGICAL CONVENTION OF ROME AND ITS RELATION TO TROPICAL AGRICULTURE.

By A. G. L. Rogers.
*Board of Agriculture.*

A movement has been on foot for many years past. among some of the leading entomologists and plant pathologists of Europe, in favour of international action in the direction and control of plant diseases. The reasoning that has led to this movement is based on the success of the International Conventions which have been founded in connection with so many subjects in recent years, and especially of the Berne Convention of 1880, ratified by nearly every European country, and having for its object the prevention of the spread of phylloxera. But this agitation might have remained unimportant and inoperative had it not been for the great number of epidemic plant diseases which have been observed lately, and the exceptional activity of certain countries in passing laws purporting to prevent the introduction of such diseases, and actually hindering international trade to a material extent. It is not only the fear of new diseases, but the fear of fresh legislative restrictions, which has given the movement in favour of international action so great an impetus in the last few years. Recent events have given it a definite shape.

On the invitation of the French Government an International Phytopathological Conference was held last February in Rome, at which, after several days' discussion, a draft Convention was prepared, which has now been submitted to the Governments of the countries represented on that occasion for their consideration and ratification. This Convention, if accepted by the principal countries of the world, as is generally expected will be the case, may have an important bearing on international trade in plants, and will profoundly influence the nature of not only the restrictions at present imposed on importation, but also the internal regulations designed to extirpate or control the more serious plant diseases. Thirty-one independent States or dependencies were represented, while one or two others who did not send delegates signified their agreement with the principle involved. There was very little disagreement among those who were present, for all were bent on securing a definite result, and the proposals were generally moderate and reasonable. But as the larger number of delegates represented European States, whose climate is temperate or only semi-tropical, it is certain that the interest of those countries received a greater share of attention in the discussions which took place than those of countries lying within the tropical zone. Representatives of Chile, Costa Rica, the Dominican Republic, the Indian Empire, and Guatemala were present, but, except in the case of India, they were all diplomatists, and apparently not specially conversant with tropical agriculture, still less with the pests which beset plants in tropical regions. No one was there to speak on behalf of any part of Africa, except the French delegates who represented Morocco, Algiers, and Tunis. There was no representative of the United States, the West Indies, Brazil, or Australia. It is only natural, therefore, that the special difficulties connected with tropical conditions were barely mentioned in the discussions, and not at all in the Convention. As, however, it was undoubtedly the intention of those present at the Conference to prepare a scheme which should be of world-wide application, it is worth while considering the details of the proposed Convention to see how far it can be adopted in hotter countries, and what would be the effect on the legislation and administration now in force in such places. I propose, therefore, to give an epitome of the Phytopathological Convention of Rome, and, as far as I am able, a short summary of the regulations in force in tropical countries, with a few observations on the changes in the latter which might have to be made if the Convention is adopted. This, I hope, will clear the ground for discussion; but as I have no personal knowledge of tropical agriculture, I must leave it to those who are good enough to listen to my paper to say how far in their opinion the Convention is applicable to the agricultural conditions with which they are familiar.

In the first place, therefore, it should be stated that the Convention aims at securing that each adhering State should take steps to eradicate, or at least control, the more dangerous diseases with which it is beset, and should devote their energies to that purpose rather than the examination of imported plants. The idea is a realization of the old proverb that if everyone swept his own doorstep we should have a clean street. With this object each State is required to maintain one or more establishments of technical and scientific research, an organization of effective inspection of all nurseries, gardens, glasshouses, and other establishments offering living plants for sale, together with an organization for the issue of phytopathological certificates of health and the regulation of transport. The word "plants" in this article means plants or parts of plants used for cultivation (though cut flowers are also included), and it excludes vines (dealt with under the Berne Convention, which it is hoped will be universally adopted), grain, seeds, potatoes, edible bulbs and roots, and fruit, as well as *produits de grande culture*, a phrase which it is difficult to translate, but which is intended to include general agricultural produce.

The countries that adhere to the Convention pledge themselves not to accept any plants unless accompanied by a phytopathological certificate, declaring either that the consignment has been duly examined and is free from certain specified pests or that they proceed from a nursery which has been so examined and reported upon. By implication, therefore, they pledge themselves to accept all consignments which are duly certified, though this is not directly stated; and it seems that in the event of any country desiring to increase the strictness of its regulations it would be at liberty to do so, though it would, of course, expose itself to the risk of retaliation. States which do not adhere are expressly debarred from getting better terms than those which are parties to the Convention. So far the procedure is based on ordinary administrative methods which are common to all countries alike, but an interesting and important provision is introduced by Article 10. It was felt by all present at the Conference that it was impossible to draw up a list of pests which should be specified in the Convention for reasons which are sufficiently obvious. It was, therefore, decided that each country should be authorized to prepare a list of pests against which it wishes to be protected, and to require that the certificate should state that the plants to be introduced are not affected with or have not been exposed to the infection of these pests. But lest the list should be made too long and should include a number of trivial diseases, it was stipulated that the list should be as restricted as possible, and should not include any plant diseases which are of old standing and are widely spread in almost all countries; that the pests should be epidemic in character and destructive, or at least very injurious in action, and should be capable of being easily conveyed by living plants or parts of such plants. Finally, no country may schedule any pest whose host plant is not found in the country to which the consignment is to be sent. There are several other articles which deal with administrative details, but they do not affect the policy of the Convention, which is contained in the part already described.

We may now compare the scheme contemplated by this Convention with the regulations already in force in the more important tropical countries, including those States which have part of their territory in the tropical zone. India, the most important of all, has, as far as I am able to ascertain, no regulations of any kind, though a law recently passed gives authority to issue orders, and it is understood that a scheme has for some time past been under consideration. In the case of others, the simplest form is that which requires that all consignments shall be fumigated on arrival without any other formality.

This appears to be the law in Ceylon, Uganda, Dominica, Grenada, St. Christopher and Nevis, Barbados and St. Lucia. In other cases this is supplemented by the requirement that the permission of the Government of the importing country must be obtained, but except in the case of Italian Somaliland there are clauses which prohibit the landing of certain plants. Thus Mauritius prohibits the importation of vines, except from the United Kingdom, and requires a licence from the Director of Forests and Gardens before other plants, including cut flowers, are admitted. Mozambique prohibits the importation of conifers and peach trees, vines which are not resistant to *Phylloxera vastatrix*, coffee plants and stone fruit of any kind from North America or other places where peach yellows and peach rosette are present, and apple trees liable to take woolly aphis. But in the case of other plants the number that may be imported is limited, and fumigation is required on arrival. Somewhat similar regulations are in force in South Africa. The Government of German East Africa has prohibited the landing of certain plants, and admits others only after permission has been obtained. The Commonwealth of Australia has apparently only prohibited the landing of gooseberry bushes, but it restricts the landing of vines to those which are authorized by a licence from the Government, and requires all other plants to be inspected and fumigated on arrival.

Very few countries have imposed the requirements that plants shall be examined and certified free from disease by an inspector of the country of origin. But this has been decided upon in the case of British East Africa, which only admits rubber, cocoa, coconuts, rice, tobacco, and potatoes on receipt of a certificate from the official agricultural authority of the countries from which the plants originated to the effect that they have been grown in areas known to be free from diseases or pests which characteristically attack such plants. A certificate of health is required in Rhodesia, but it appears that the seller is made responsible for the certificate and not the Government. The Peruvian Government require a licence from their Ministry of Agriculture before importation, and this will only be issued when a certificate as to freedom from disease given by the competent authority at the place of exportation is produced. New Zealand, though scarcely a tropical country at all, and the United States, only part of which is tropical, also require a Government certificate before admission.

The certificates demanded in each case relate to the general health of the plants, and no attempt is made to define what the pests are for which examination should be made. Two countries, however—Australia and New Zealand—have given a clue as to the diseases "against which they wish to be protected" by publishing a list of the diseases which have been scheduled as affecting plants. In both cases the list is long and comprehensive, and in Australia it includes Mucor and Penicillium, so that the task of the inspector in that country must be a difficult one.

It is not pretended that this description is exhaustive, and no doubt many countries have modifications of the regulations described above which affect importation in other ways. Much also depends on the way the laws are administered. It is believed, however, that there are no regulations which cannot be classified under one of these categories. If, therefore, they are compared with the regulations contemplated by the Rome Convention certain points attract attention at once:—

(1) Most of the plants which are the subject of the restrictions—tea, coffee, rubber, cotton, etc.—are products of general consumption which have no exact analogy in temperate agriculture. It is possible, therefore, that a special article must be introduced to regulate the trade in these commodities, or they might even be excluded from the Convention altogether. On the other hand, the Rome Convention is avowedly only a beginning, and as the phytopathological services of each country improve fuller responsibilities will be undertaken, and the list of exempted plants restricted.

(2) With hardly any exception the method adopted in tropical countries against the introduction of disease contemplates preventive measures at the frontier of the country of destination, while the scheme underlying the

Rome Convention implies examination at the place of origin. This is a wide and important difference involving a question of principle, and unless the Governments of tropical countries can see their way to adopt this change it seems to be impossible for them to ratify the Convention. The advantages and disadvantages need, therefore, to be carefully considered. The latter are, of course, obvious. The large size of most tropical States, the difficulty of means of communication, the smallness of the white population in many instances, and the difficulty of securing a strict compliance with the law among the native or coloured races make inspection difficult and evasion an easy matter. The number of pests, both those that are known and those that are not, increases the difficulty, while the rapidity with which an imported pest will spread and the obstacles in the way of overtaking it seem almost insuperable objections. At first sight, therefore, the arguments in favour of examination and treatment at the port of landing seem almost unanswerable. On further consideration, however, there seems much to be said for the opposite point of view. Fumigation at the port of landing may be a satisfactory means of preventing the introduction of disease, but it does not appear to be more efficacious than fumigation at the port of departure; and if the diseases against which the country wishes to be protected are known, an examination of the consignment by a competent inspector is in most cases as good. All that is necessary, therefore, is that consignments that are exported should be examined and treated, if necessary, instead of those which are imported. Moreover, if the examination can take place at the premises where the plants were grown, there is not only a much better chance of detecting the disease, but the results are more satisfactory, since it is clearly better to search for and destroy disease in one's own country, where the discovery may lead to national benefit, than to expend one's energies in excluding the disease from elsewhere. Nearly all tropical countries—certainly all of moderate size and longer settlement—aim at the control of some plant diseases in home farms and plantations, and all that is necessary is the extension of this principle a little further. In theory it is probable everyone will agree, but will object that in practice it is impossible, because no country will trust the certificate of any other country. It will be objected that the examination will be perfunctory where it is not ignorant, and that diseases will be found on consignments officially declared to be free. The same fear, it must be admitted, was present among some of the delegates at the Rome Conference, but as it was most conspicuous in those countries whose system of inspection was the least satisfactory, there is some reason for thinking that the fear is bred of the knowledge of their own deficiencies. The proper remedy is for each country to perfect its own service, and it will then quickly be able not only to detect the faults of others, but to remedy them when they arise.

The adoption of this principle in most European countries has proved a national advantage, since it has enabled the Government to secure for home consumers the same advantages which are obtained for foreign customers without additional cost, and has undoubtedly led to an improvement in the general cleanliness of nursery stock.

In conclusion, therefore, it would appear that, though most tropical countries may have to modify their regulations drastically if they desire to adhere to the Convention, it will not prove an exceptionally difficult task to do so; while the advantages which will result therefrom will be of great benefit to the home consumer, and will tend to promote international trade instead of hampering and restricting it, as do so many of the regulations in force at the present time.

# COTTON.

## THE WORK OF THE BRITISH COTTON GROWING ASSOCIATION.

By J. Arthur Hutton.

*Chairman of the Council of the British Cotton Growing Association.*

It would be quite impossible in a short paper to give a full account of the work carried on by the British Cotton Growing Association during the last twelve years, and, therefore, on this occasion I do not propose to go into any detail, but rather to give a general idea of our successes and our failures. Naturally in all pioneering work one must make mistakes in learning the best methods of working, but I can say with pride, that the Council have never been afraid of publishing their failures, for they have rightly regarded them as the means of ultimately attaining success.

Before dealing with the work of the Association I propose to give you a short account of the formation of that body. In January, 1901, at the Annual Dinner of the Oldham Chamber of Commerce, Mr. Benjamin Crapper, one of the most active members of the Council and the Chairman of the East African Committee of the Association, drew attention to the dangerous position of the Lancashire cotton industry, owing to the fact that it was dependent on the United States for the bulk of its supplies of the raw material, and, therefore, that the industry was at the mercy of the vagaries of the weather in one particular part of the world. I need not dwell on the sufferings which were subsequently caused when the mills had to be put on short time owing to the failure of the American crop, nor need I do more than draw attention to the obvious fact that the only way by which such calamities can be avoided in the future is by the establishment of cotton growing in all parts of the world. If the basis of supply is broadened, and if cotton is grown in quantity in Africa and other countries as well as in India, Egypt, and the United States, one can regard the failure of the crop in any particular part of the world with equanimity, for in all probability it would be balanced by more favourable climatic conditions elsewhere.

The Oldham Chamber of Commerce promptly followed the matter up by appointing a Committee to inquire into the question. A considerable amount of correspondence took place with the Colonial Office, Governors, and other Colonial officials, and their report was published in November, 1901. The report may be summed up in one sentence. In the opinion of the Committee:

> "Suitable cotton for the Lancashire trade could be grown in various parts of the British Empire."

This report was circulated amongst the other Chambers of Commerce, and on February 18th, 1902, a representative meeting was held at the Manchester Chamber, when an influential committee was appointed. In the meantime the late Sir Alfred Jones, with his usual energy and zeal, had already commenced operations on his own account, and had sent out ten tons of American seed to West Africa in May, 1901. Acting as Chairman of the West African Committee of the Manchester Chamber of Commerce, I invited Sir Alfred Jones and some of the leading West African merchants, to dinner on May 7th, 1902, at the Albion Hotel, Manchester, to meet representatives of the cotton trade, and at that dinner the British Cotton Growing Association was born.

A general meeting of various Associations and other bodies interested was held at the Manchester Chamber on June 12th, 1902, when the Association was formally inaugurated with a guarantee fund of £50,000. Sir Alfred Jones was elected President, and Mr. J. E. Newton Chairman and myself Vice-Chairman of the General Committee. Active operations were at once commenced, and several cotton experts were sent out to various parts of the Empire to inquire and report. It was very soon realised that the funds at the disposal of the Committee were quite inadequate, and at a meeting held in November, 1903, it was decided to increase the Guarantee Fund to £100,000. By this time the Committee were able to realise how enormous was the work they had taken in hand, and also that for a considerable period a large amount of pioneering work would have to be undertaken, and that as this work could not be remunerative for some little time it would be difficult to get ordinary capitalists to interest themselves in the work. It was not originally intended that the Association should attempt to do more than make inquiries and carry on a small amount of experimental and missionary work, but it very soon became apparent that unless the Association undertook the entire supervision of the industry and the actual buying and ginning of the cotton, very little good could be done.

In January, 1904, owing to the shortage in the supply of American cotton, the situation in Lancashire became so much more serious that it was decided to reconstitute the Association on a permanent basis, and to apply to His Majesty, the late King Edward, for a Royal Charter. On August 27th the Charter was finally sealed, and the Association was reconstituted with a capital of £500,000, of which £471,000 have been actually subscribed.

Sir Alfred Jones was the first President of the Association, and I must here record the very great debt of gratitude owed to his memory by all who are interested in the welfare of the British Empire. It is mainly due to his untiring energy and to his splendid generosity that the Association has been able to achieve its present position.

As you are all aware, on the death of Sir Alfred Jones the Earl of Derby very kindly consented, on the unanimous request of the Council, to accept the position of President of the Association, and we are all most grateful to him for the invaluable services he has rendered to the Association.

In 1906, owing to ill-health, Mr. J. E. Newton had to retire from the position of Chairmanship of the Council, and I was appointed in his place.

I must draw attention to the fact that the Association is absolutely representative in character. Its members consist of spinners and manufacturers, merchants and shippers, and representatives of all the various industries connected with the Lancashire cotton trade, and further than that, many of the Labour bodies are taking an active interest in the work, and some of their representatives are the most useful members we have on our Council. I should also draw attention to the fact that the capital has been subscribed mainly for the purpose of extending the growth of cotton and not for the earning of dividends, in fact it was stipulated in the prospectus that no dividends should be paid for a period of seven years.

Before dealing with the actual work, I should like to draw attention to the great assistance which has been rendered to the Association by His Majesty's Government and by both political parties. The philanthropic character of the Association, and the beneficial nature of its work, is fully recognised at the Colonial Office, and I might almost go so far as to say that the officials there look on the Association almost as a Department of their office. They realise as no one else does, that wherever we go, and wherever we are successful, we carry prosperity with us, though it frequently happens that the Association itself is the only body which derives no profit from its transactions. Thanks mainly to our efforts, many of the West Indian Islands which were in a serious financial position are to-day in a state of prosperity. Thanks largely also to our work, cotton is the leading article of export in Nyasaland and Uganda, and "grants-in-aid" from the Imperial Government to these Colonies have become a thing of the past. Also in Nigeria cotton provides a large portion of the revenue of the railway, and that Colony has benefited in many other directions, for it is manifest that every pound's worth of cotton exported has to be paid for by a pound's worth of imported goods, with consequent benefit to the revenue of the Colony. There is an old proverb: That the real benefactor of mankind is the man who makes two blades of corn grow where one grew before. Equally so the man who can get cotton grown where none grew before is conferring invaluable benefits both on the native who grows the cotton and on those who spin it into yarn and weave it into cloth, and also on the railway and shipping interests, and all the other allied industries and trades.

There is a further point to which I must draw attention, and that is the valuable and disinterested advice which the Association are able to give to the officials at the Colonial Office and also in our Colonies. During the twelve years we have been at work we have acquired valuable experience, and the officials know that when we offer any advice or urge any particular course of action, we have only one object in view, and that is the development of cotton growing in the British Empire. Knowing this, we naturally are most careful in any representations we put forward, and we never urge the Government to take any particular step, whether it be the building of a railway or the guaranteeing of a Colonial loan, unless we are convinced that what we urge is in the interests of the Empire. I say it with pride that we have never yet asked the Government to take any particular step without meeting with success. I can only hope that the Association may be able to retain its present semi-philanthropic character, and obtain the necessary funds for it to continue its work on a permanent basis. If anything were to happen which necessitated the winding-up or dissolution of the Association it would be a disaster for the Empire.

The work of the Association may be divided into three periods:—

(1) Inquiry.
(2) Experimental.
(3) Development.

The first and second periods are practically over, for there is no part of the Empire capable of producing cotton in any quantity which has not been fully inquired into by the Association, and in many cases experimental work has actually been carried on. We are now in the third and perhaps the most difficult stage, and that is development, for development means capital, and it is by no means easy for a semi-philanthropic body to raise capital.

During the first two periods our inquiries and experiments were extended throughout the greater part of the British Empire, and the Council have now decided that as far as any large results are concerned the districts which offer the best prospects are:

(1) India.
(2) Uganda and Nyasaland.
(3) West Africa.
(4) The Anglo-Egyptian Sudan.
(5) The West Indies.

No doubt there are other parts of the Empire where cotton can be grown, but the Council have decided that their main energies must be concentrated on those countries, and therefore on the present occasion I only propose to deal with this portion of the work.

## INDIA.

It is held by many, and with some justification, that India offers the best prospect of large and quick returns. In 1902-3 the Indian crop amounted to 3,855,000 bales, and had increased to 5,197,000 bales five years later. There was a falling back in the next two years, but in 1909-10 the crop touched the record figure of 5,317,000 bales, only to fall back again to 4,078,000 bales in 1911-12. It will be seen at once that the fluctuations are very large, as I suppose must always be more or less the case with agricultural crops, which are naturally dependent on the vagaries of the weather. There is, however, one serious disadvantage connected with Indian cotton, and that is the fact that the bulk of it is far too short for anything but the coarsest yarn, and not one Lancashire spinner in a hundred could make any use of Indian cotton. It is principally used on the Continent, and in Japan, and in India itself. At the same time it must not be forgotten that if there is an increase in the quantity of cotton produced in India it will to a certain extent reduce the demand for long-stapled cotton. It would, however, be dangerous to attach too much importance to this argument, for the world requires better and finer qualities every day, and consequently the demand for medium and long-stapled cotton is increasing correspondingly. The principal demand in Lancashire is for cotton from 7/8 inch to 1 1/4 inches in length, and there never was a period in recent years when there was so great an actual scarcity of cotton about 1 1/8 inches long. Most cotton is bought and sold on the basis of futures, or paper contracts, with a premium, or the opposite, according to the quality of the actual cotton. At the present moment spinners are having to pay 100 points on, or a premium of one penny per pound for cotton which a few years back could have been bought at a price of one-farthing per pound over contracts.

It is evident, therefore, that the main efforts of the Association should be devoted to the production of cotton of longer staple than that grown in India. At the same time there is danger of growing cotton which is too long for the average spinner, and especially so when such cotton is not grown under the best conditions. When the staple exceeds 1 1/4 inches in length it can only be used by spinners who are spinning the finer counts, such as are usually spun from Egyptian cotton, and for this purpose cotton which is coarse and irregular in staple, or wasty or soft, or stained, is difficult to use, and is discarded by the spinner. In other words, unless long-stapled cotton is well grown it is almost unsaleable, and in addition the market for this class of cotton is to a certain extent a limited one. It would be easier to sell hundreds of thousands of bales of inch cotton than it would be to find a market for a few hundred bales of cotton 1 1/4 inches long.

The Association felt that as far as India was concerned the Government of India was the only body which could do any good, and one of the first steps they took was to send a deputation on February 27th, 1904, to Mr. St. John Brodrick, who was then Secretary of State. They drew attention to the great importance of increasing the quantity of cotton, and special emphasis was drawn to the necessity of improving the quality. It was also pointed out that if India could grow a superior type of cotton, the grower would be able to command a wider market and a better price for his produce. This was followed up on September 5th, 1904, by a despatch to the Viceroy, Lord Curzon. This despatch will be printed in full as an Appendix to this Paper. The principal steps recommended by the Association were as follows:—

1.—The establishment of Government seed farms, where experiments could be carried out with different varieties of seed, both indigenous and exotic, and where continual selection from the best varieties could be made from year to year, so as to ensure a supply of the best possible seed to the native cultivators. This is *the most vital factor* in successful cotton cultivation, and much of the prosperity in the United States is due to the continual efforts of the Agricultural Department, planters, seed suppliers, and others to obtain new and improved strains. Similar efforts in India with wheat have been most successful.

2.—To carry on at these farms experiments with fertilisers, and better methods of cultivation, with the view of giving the natives a practical object-lesson of the advantage to themselves of an improvement on their present methods. These farms would also afford valuable training grounds for native experts, who could afterwards act as advisers in other districts.

3.—The establishment of a special Agricultural Department devoted solely to cotton, with a staff of experts with a scientific knowledge of the best modern methods pursued in the United States and Egypt. In addition to the Central Institution there should be an efficient staff in each Province, who should supervise and assist locally in all questions connected with selection of seed, better methods of cultivation, the use of fertilisers, and ginning and grading of cotton.

4.—The establishment of Agricultural Banks on similar lines to those in existence in Egypt, so as to enable the native planter to obtain financial assistance on reasonable terms, and thus reap better profits than he does now.

5.—The carrying out of a thorough survey of the existing varieties with a view to the selection of that most suited to each district and to its ultimate improvement.

There is no doubt that much of the scientific work which has since been carried on by the Indian Government is a result of the representations made by the Association.

Acting in co-operation with the Government of India the Association voted the sum of £3,000, which, with a similar amount from the Government, was to be spent on certain experiments, which were carried out by Messrs. Shaw, Wallace, and Co., in endeavouring to establish perennial or tree cottons. I regret to say that these experiments were a failure, and it is rather remarkable that various experiments carried out in several colonies with Caravonica and other perennial types of cotton have been unsuccessful.

In 1905 the Council voted a sum of £10,000 to be spent by the Government of India in experimental work. Of this amount the sum of £2,000 was actually spent, but afterwards, in view of the heavy demands on the Association in other Colonies, the Government agreed that the Association should be relieved of further liability in the matter.

In 1911 representations were made to the Association that local buyers in India would not pay a suitable price for improved qualities of cotton, and that it was of very little use for the Department of Agriculutre to raise and distribute supplies of superior seed unless a higher price was paid for the better than for the ordinary cotton. The Association then offered to establish buying stations and to erect one or two ginning and baling factories, provided that the Indian Government would take half the risk, and would share either the profit or the loss as the case might be, and the Association would undertake that the native farmer should receive the highest possible price for his cotton. In consequence of representations from Bombay spinners and merchants, which were perhaps not altogether disinterested, the Indian Government were unable to accept the Association's offer, which would certainly have ensured that the native farmer was properly rewarded for his labour.

Since then the Association have not taken any further practical steps in India, for they feel that the Government are now thoroughly alive to the great importance of the question, and fully realise that it is to the advantage of the natives to grow cotton, not only in increased quantity, but also of improved quality, so as to be able to command a larger market for their produce. From time to time the Association continue to render valuable assistance to the Government by reporting on samples of new types of cotton. Owing to their close connection with the Lancashire trade, both with spinners and brokers, they are in a particularly favourable position to judge as to the suitability for the market of any new type of cotton. When all is said and done, the buyer has the last word in the matter, and it is most important that the farmer should grow the cotton which the spinner wants.

## WEST INDIES.

In some ways the results obtained in the West Indies are the most satisfactory, for the West Indian Islands are producing a sufficient quantity of Sea Island cotton to fully meet the present demand. Unfortunately, owing to the existing style of ladies' dresses, the demand for lace has fallen off very much, and consequently the demand for the highest class of cotton has not increased during recent years. One can only hope that the present rather unbecoming fashions may change, and that the demand for Sea Island cotton may increase, and that the Association will be able to advise the planters to increase the acreage under cotton.

In connection with the work in the West Indies, there was one great advantage. The Imperial Department of Agriculture, which was then under the able management of Sir Daniel Morris, was a thoroughly equipped organisation, with an excellent staff of scientifically trained experts, such as existed in no other part of the Empire. As soon as the cotton proposition was placed before Sir Daniel Morris, he at once grasped the great possibilities of the question, and what was perhaps more important, he was able to take immediate steps to ensure that the planters should receive supplies of seed of the highest possible quality. Mr. Lomas Oliver, who is a member of our Council, and who himself uses the best quality of Sea Island cotton, paid two visits to the West Indies, and I accompanied him on the second occasion. I cannot express too high praise for the excellent work which was being carried on by Sir Daniel Morris, who has been so ably succeeded by Dr. Watts. I could only wish that the authorities would realise the vital importance in agricultural countries of a fully equipped and trained agricultural department. As a rule the organisation which looks after agriculture is generally the "Cinderella" of the Government Departments. No doubt the other Departments are of considerable importance, but a few years ago in many of our tropical Colonies there were no Agricultural Departments of any sort whatever, and even to-day in the majority of cases they are not much to boast of. What is most lamentable is that the Imperial Department of Agriculture is not to-day in the position it was a few years ago, and this is partly the fault of the West Indians themselves. Each island wants to have its own Department of Agriculture, and refuses to bear its share of the cost of the Central Department. It will be evident to anyone who takes a disinterested view of the matter, that a large central and important organisation can work more effectively and more economically, and will attract the highest class of men, who would hardly care to join a small local department. It is far better to have one or two well-paid men of high scientific standing than half-a-dozen men of second-rate ability.

The Association have made several money grants to the West Indies, for the payment of experts, for the erection of ginning machinery, and for financing crops, etc., and such help is still being given. The principal assistance they render is in marketing the cotton, and in advising the agricultural authorities as to the market values of the various types of cotton, and they do all in their power to ensure that the grower receives the highest possible price for his cotton. Sea Island is not everybody's cotton, and it is not always easy to find a quick market for it. The Association, however, recognise that if the industry is to continue it is most important that the planter should be paid a good price. In this connection I must draw attention to the great gratitude we all owe to Mr. Charles Wolstenholme, of Liverpool, who has I know sacrificed much of his time and his business in his endeavours to help the planter. Thanks to the Imperial Department, and thanks to Mr. Wolstenholme, some of the best cotton in the world is to-day being grown in the West Indies.

## WEST AFRICA.

In commencing operations in West Africa, the Association had two difficulties facing them, viz., the huge extent of the country, and lack of any properly equipped Agricultural Departments. Cotton as an article of export was non-existent, and there was no one to whom to apply for definite information as to where cotton could or could not be grown, and it was impossible to say where good results might be expected. Everything had, as it were, to commence at the very beginning.

The British Possessions in West Africa cover an area of about 450,000 square miles, and the population is about

20,000,000. This area of 450,000 square miles represents an extent of nearly 300,000,000 acres, or about three-quarters of the area of the cotton States of America. It is therefore evident that the extent of territory to be investigated was enormous.

As regards the question of Agricultural Departments, I must point out that owing to inexperience, and owing also to the fact that there was not a single official in West Africa who had any practical experience of cotton growing, the Association was obliged to spend large sums of money not only in proving where cotton could be grown, but also where it could not be grown. I do not think I can exaggerate the importance of this point. Money spent in scientific investigation in tropical countries will ultimately save the waste of hundreds of thousands if not millions of pounds. This applies just as much to rubber, sugar, and other products as it does to cotton. Time after time the Association made representations to this effect to the authorities at the Colonial Office, and I am afraid even to-day the absolute necessity of having a properly equipped Agricultural Department in each of our Colonies is not fully realised. After continued representations, in 1904 the Government appointed Mr. Gerald C. Dudgeon as Superintendent of Agriculture for West Africa, but on his retirement the vacancy was not filled. I am glad to say that the position to-day is somewhat better than it was in 1902, when the Association first commenced operations. One great difficulty is that there is no proper system of training experts. Further, there is no organised system for collecting and collating information so that one colony can benefit by the experience of another.

In order to meet this want the Association urged the Government to organise a central authority or Bureau for Tropical Agriculture. A small scientific committee was appointed, but I am not aware whether this Committee ever held a meeting. I have at any rate never seen any report of its proceedings.

The Association on its part, as a first step, in 1903 engaged a number of practical planters from America, and these men were sent out to Gambia, Sierra Leone, the Gold Coast, Lagos, and Southern Nigeria. It was then found that cotton of fair quality was growing in the wild state, and that in various districts a considerable quantity was grown for local consumption.

I will not weary you with the details of the work, but I must draw attention to one important fact, which we very soon discovered. Owing to the climate the European cannot work in the open in West Africa, and he also has to return on leave at frequent intervals to recover his health. Our first term of service was twenty months in Africa and 4 months on leave, with full pay. We soon found this was too long, and the service was subsequently altered to 15 months in Africa with three months' leave, and in certain districts our employees remain 10 months in Africa with 2 months' leave. The cost of passages on the steamer to and from Africa is in consequence very heavy, and this coupled with comparatively large salaries renders it necessary to keep the number of white employees as low as possible. For this reason it is extremely difficult to work a large plantation in Tropical Africa economically. Further, the native will do better work when farming for himself than when employed as a hireling. The Council therefore decided to devote their principal energies to establishing cotton growing as a native industry, and it is almost a truism to state that, generally speaking, *cotton is a black-man's crop.*

In 1904 an agreement was entered into with the Government that model farms should be established in various centres for carrying on experiments with different varieties of seed, etc., which should ultimately become seed farms for the distribution of seed. The cost of these farms was to be borne by the local Governments. The reason for this agreement was that we had discovered that cotton growing was not merely a question of shipping out so many hundred tons of American and Egyptian seed, and expecting that the natives would sow it and reap good crops. Judging from our experience, one requires at least three or four years' patient work before one can decide that any exotic seed will do well in any particular district. One might go further, and state that it by no means follows that a variety which does well in one district will do equally well in another part of the same Colony.

The Association on their side undertook for a period of three years to purchase all seed-cotton offered at a minimum price of 1d. per lb., and to establish buying and ginning centres where required. They further undertook to provide experts who would travel round the country preaching the gospel of cotton growing.

This agreement was subsequently modified, and it was arranged that the Association should take over the experimental work at the plantations, and that the Governments of Sierra Leone, Lagos, and Southern Nigeria should pay the Association £6,500 per annum, and the Association undertook to spend £10,000 annually in each of the three Colonies on experimental work.

The result of the work on these experimental farms proved that, regarded as plantations from a commercial point of view, they would not pay. The results of the experiments were published in pamphlet form by the Association, and the main point which was proved was that after a certain number of years exotic cottons could be established so as to give satisfactory results, and some of the best crops were obtained from imported Upland American seed after it had been thoroughly established. At the same time let me point out that in the early stages of the industry it is extremely dangerous to distribute broadcast large quantities of exotic seed which have not been established, and it is better to commence with local varieties. If the quality of these is unsatisfactory, they can subsequently be replaced by exotic cottons after the same have been thoroughly proved and established.

It is difficult to say whether the methods of cultivation practised by the natives can be improved upon. They are the result of long experience, and nothing but practical proof of other methods would justify one in persuading the natives to abandon the methods which many years' experience has shown to give the best results.

One thing is quite certain, and that is that the distribution of seed should either be in the hands of the Government or under Government control, and the Association have on frequent occasions made representations to the Colonial Office to this effect.

As it was found to be unwise to distribute exotic seed the Association endeavoured to improve the local varieties by selection, and this was done in bulk in perhaps rather a rough and ready way at the ginneries. Samples of each lot of cotton were sent home, and instructions were sent out to reserve certain lots for sowing purposes, and either to destroy or ship home the seed from undesirable cotton. This may not be a very scientific method, but in Lagos the results have been most satisfactory. The Association have absolute control over the distribution of seed, and I should also add have to bear the cost of the same. In the early days there was great variation in quality—some of the cotton was worth one-farthing per lb. more than Middling American, and some was difficult to sell at 1d. below contracts, a difference of 1¼d. per lb. To-day Lagos cotton is the most regular and even in quality of any cotton produced in any part of the world, and the bulk of the crop is sold at prices ranging from 10 to 20 points on Middling American. This is entirely due to the work carried on by the Association, and it is no exaggeration to say that if they had absolute control of the industry in each colony it would be of immense advantage to the welfare of the district. The Association have to sell the cotton, and therefore are in a much better position to judge which type will give the best results.

It was subsequently decided that each Colony should take over the experimental work, and I cannot say that the results have so far altogether justified the change. But it must not be forgotten that most of the men who took the work over had had little or no experience of cotton growing, and had to begin *ab initio*.

While on this point I should like to say a few words on the present quality of West African cotton, and as to how it might be improved. Unfortunately, as a rule, West African cotton gives a very bad ginning return, and the proportion of lint is only about 27 per cent. In other words, it takes 3¾ lb. of unginned or seed cotton to give one pound of lint. If, therefore, the buying price is fixed at 1d. per lb. for seed cotton, the first cost works out at 3¾d. per lb. of lint cotton, and when one has allowed for cost of buying, ginning, financing, freight, insurance, brokerage, and other charges, the cost in Liverpool will work out at about 6½d. per pound, which leaves very little margin for profit. If a variety which gave 33 per cent. of lint could be established, one could increase the buying price to 1¼d. per pound, or by 25 per cent., without increasing the cost delivered in Liverpool. It is therefore evident that a variety which gives a better percentage of lint is to be aimed at. West African cotton is also rather on the short side, and also of a rough and harsh character, and rather brown in colour, and other things being equal it would certainly be an advantage if a variety could be established rather whiter in colour and of a more silky nature. The one great advantage of West African cotton, and which gives it its value is the fact that it is exceedingly strong, and gives very little waste in spinning, and therefore I would sooner stick to the present varieties rather than introduce a new cotton, which, though longer, whiter, and silkier, was of a soft and wasty character. If cotton is really strong the spinner will overlook many other faults, but when the market is well supplied, soft and weak cotton is almost unsaleable.

When the local Governments decided to take over the experimental farms a new agreement was entered into with the Home Government, and it was arranged that the Association should receive a grant of £10,000 per annum from Imperial funds, for a period of three years, terminating on March 31st, 1913. This agreement was subsequently extended for a further period of three years to March 31st, 1916. This grant was given on condition that the Association should raise £150,000 additional capital, and the Association further undertook to establish and maintain seven pioneer ginning and buying stations as follows:—

Gold Coast, at Labolabo and Tamale.
Southern Nigeria, at Illushi.
Northern Nigeria, at Lokoja, Zaria and Kano.
Nyasaland, at Port Herald.

The Association further undertook to provide seed for sowing free of charge in the above-mentioned Colonies, and also in Lagos. I should mention that the cost of this in Lagos alone in 1913 amounted to £1,700. The Association further undertook that their staff should give up a considerable portion of their time to missionary work. The Association are most grateful to His Majesty's Government for this valuable monetary assistance, without which they would have been compelled to curtail their work. There is, however, no doubt that the Government acted wisely in giving this help to the Association, for not only has the latter spent the whole of the grant on pioneering work, but has also spent a good deal of its own money as well. For example: In 1912 the cost of working the various branches in Africa amounted to £16,532, so that after deducting the Government grant, the Association were actually £6,532 out of pocket in actual cash alone, in addition to the time and labour devoted to the work. I should also point out that it is more than probable that the best possible value was obtained for the money spent, for it is an admitted fact that in the nature of things Government Departments cannot work as economically, as efficiently, or as expeditiously as commercial men.

One great advantage in West Africa was the fact that there were a large number of merchants established in the various Colonies, and the Association cannot thank them sufficiently for the valuable co-operation they have given. An agreement was entered into, and the merchants undertook to purchase all cotton offered to them on account of the Association, and in consequence each merchant's trading factory became a buying station for the

Association. The merchants receive a fair remuneration for their services, and the Association benefit by economies in the cost of a special staff for buying cotton. I should also mention the great advantage of having a thoroughly good bank established in a Colony. Cotton must be bought with actual cash, and thanks to the Bank of British West Africa, the Association are able to obtain all the cash required even at outlying stations.

The one great difficulty in West Africa, and indeed throughout Africa generally, is the difficulty of transport. African rivers, with the exception of perhaps the Nile and the Congo, are generally too low for transport at the time when cotton is coming forward, or else they are broken up by rapids. In Nyasaland I have known cases when 12 months have elapsed between the time the cotton has been gathered and when the proceeds could be realised in Liverpool. At this very moment 500 tons of seed cotton are lying at Yelwa on the river Niger, and it will be impossible to transport it before December, when the river rises. Even then it may not be practicable, for there are several stretches where the river is broken up by rapids.

There is no doubt that cotton growing in Africa can never be really successful until the country is opened up by railways, and this applies not only to cotton, but also to other products. In West Africa, speaking generally, along the coast line and for some distance inland, the rainfall is far too heavy for successful cotton cultivation, and the Association soon discovered that their efforts must be devoted to the interior. Consequently in season and out of season they were continually urging the Government to make railways, and it is largely in consequence of their representations that the Lagos railway was extended from Ibadan to Jebba, and that the Baro-Kano railway was put in hand. Luckily, it seems almost impossible to put down a railway in Africa which does not pay, and even if a railway barely covered working expenses the indirect benefits would more than balance the cost of interest and sinking fund. In any case, it is a waste of labour and material to convey produce on men's heads. The time which is thus occupied in porterage would be better spent in growing cotton.

In this connection, I should draw attention to the great value of the conferences which are periodically held at the Colonial Office between the permanent officials and representatives of the Association, under the Presidency of the Under-Secretary of State. We all owe a great debt of gratitude to the Duke of Marlborough, who inaugurated this wise and businesslike procedure. There is no doubt that meetings of this sort save an immense amount of time and misunderstanding, and it would be a good thing if those officials who are connected with cotton growing in Africa or elsewhere would occasionally visit us in Manchester. I can promise them that we would receive them with all hospitality, and I think both sides would benefit by an interchange of ideas.

It was only fitting that the first large saw-ginning factory to be erected in the British Empire should have been named after the Duke of Marlborough, and the Marlborough Ginnery at Ibadan has turned out many thousands of bales since it was first erected in 1905. In this connection I should just point out that large ginneries are much more economical than small ones, and especially so as the cotton can at once be efficiently packed in a hydraulic baling press. It is a most dangerous thing to gin cotton in small ginneries and then to convey the lint in lightly-pressed bales to a central baling factory. We have suffered very much from stained and damaged cotton by this method of working, but once the cotton is efficiently baled, it will stand a good deal of exposure without damage. Probably in the early stages of the industry small ginneries may be necessary, but one cannot have a powerful hydraulic press at each small ginning factory, and our experience leads us to believe that it is better to incur the increased cost of conveying the cotton in the unginned state to a large central ginning factory. There is also the further point that the spinner does not like small bales, and in addition the charges for handling the same are higher in proportion. It is no exaggeration to say that cotton packed in large hydraulic pressed bales will nett at least one halfpenny per pound more than when loosely packed in small bales.

The Association's present type of ginnery consists of two batteries of four gins each, with 70 saws in each gin. The cotton is automatically conveyed by pneumatic feed to the gins, and thence to the press, which will turn out eight bales of 400 lb. of lint cotton per hour, or about 12,000 bales in the season. The weight of the bales is regulated by an electric attachment, so that each bale contains exactly 400 lb. of lint, consequently when a spinner buys so many bales of cotton he knows exactly what amount of cotton he will receive. The bales measure 80 cubic feet to the ton weight, giving a density of 28 lb. of cotton for each cubic foot. We adopted a standard of 400 lb. as being more easily handled than bales of heavier weight, and the bales are much liked by spinners. I do not think the Association have now much to learn about ginning and baling cotton.

The seed is conveyed to hoppers, where it is automatically weighed as it is sacked, and each sack contains the same weight.

The motive power is usually obtained from two or three gas engines of 100 h.p. each of the vertical type with four cylinders each, which ensures a steady drive. The gas is made from cotton-seed, so that power is obtained at a minimum cost, for as a rule in out-of-the-way districts in the centre of Africa cotton-seed has little value and coal and oil are most expensive. Generally ample storage is provided at each ginnery, for there is no doubt that cotton improves by lying unginned for some little time after picking. Each large ginnery is also protected against fire by automatic sprinklers.

I should also mention that the Association spare no expense in providing good quarters for their staff, and the bungalows are usually two storeys high, the living room being on the first floor, which is a great advantage in a tropical country.

Amongst other experiments, the Association erected a small plant at Ibadan to extract the oil from the seed, but, judging from experience, unless there is a local market for the cake and the oil it is more economical to send the seed home and to sell it to the oil mills in this country.

Before I leave West Africa, I must say a few words about the results obtained. We have spent a good deal of money, but we have acquired most valuable experience. Speaking generally, as far as rate of progress is concerned the results have been somewhat disappointing, and there is no doubt that affairs do not march as rapidly in West Africa as one could wish. Gambia was a failure, as the natives preferred their old industry of growing ground-nuts. In Sierra Leone the rainfall was too heavy for cotton to be a success. In the Gold Coast the quality was excellent, but apparently cocoa was more suited to the climate. Work is still being carried on there and also in the Northern Territories, but the quantity of cotton produced is infinitesimal. In most parts of the Eastern Province of Nigeria the rainfall is far too heavy for cotton, and had it not been for the excellent quality of the Ishan cotton—the best grown in British West

Africa—this centre would have been closed down. There may, however, be possibilities on the new railway between Port Harcourt and the Niger. In the Lagos Province the results have been most satisfactory, and last year's crop was over 13,000 bales. In Northern Nigeria a large quantity of cotton is grown, but owing to the demand for local consumption the ruling price is prohibitive. Sooner or later European cloths must displace the native manufactures, but in the meantime we can only hope that the Agricultural Department may be able to establish a variety for which the Association will be able to pay a higher price.

West African cotton now commands a ready market in Liverpool, which is perhaps best shown by the fact that the Liverpool Cotton Association have established standards for West African cotton. The quality, thanks to the Association, is now so regular and reliable, and the cotton is so excellently ginned and baled, and the B.C.G.A. mark has acquired such a reputation for regularity and honesty, that the whole of each year's crop could be sold before it is even planted. The Association make a point of paying the highest possible price to the natives, and more often than not their cotton-buying account shows an actual loss.

## BRITISH EAST AFRICA.

The results obtained in British East Africa have been disappointing. The Government commenced some experimental plantations, and the Association sent out a small ginning plant to Mombasa. It was later arranged that the Association should undertake the experimental work, and eventually this was handed over to the British East Africa Corporation when they were appointed the agents of the Association. The plantation worked by the Corporation was not a success and had to be abandoned, and I am sorry to say that several other companies have been equally unsuccessful. This is partly due to unfavourable climatic conditions, though it is quite possible that better results might be obtained by trying to establish cotton growing as a native industry. Some fair results have been obtained with native cultivation in the Kisumu district adjacent to Lake Victoria.

The main interest to the Association in East Africa is the fact that Mombasa, or rather Kilindini, is the terminus of the Uganda Railway and the outlet for Uganda cotton. It has been suggested by several of our numerous critics that the Association does nothing for Uganda. So far from this being the case, I can assure them that at almost every conference held at the Colonial Office the question of Uganda cotton has been brought forward in one way or another, and I have no doubt that at times the officials have looked on the Association as an intolerable nuisance.

For many years we continually urged the importance of a direct service of steamers to and from Kilindini, Port Sudan, and other ports in our East African possessions, and it is largely due to representations made by the Association that we now have a regular service of steamers from England to East Africa. The Union Castle Company deserve every credit for what they have done to meet this long-felt want.

One of the principal difficulties in establishing cotton growing in new fields is transport, and when the cultivation of cotton began to extend in Uganda there was a serious shortage of steamers on Lake Victoria and of trucks on the Uganda Railway. This has now been put right, and the Uganda Railway is now a paying concern, thanks mainly to the revenue derived from the carriage of cotton and seed and of the imported goods to pay for these.

There is a fine harbour at Kilindini, but the wharfage accommodation is inadequate for the traffic, and the Association have continually urged the Colonial Office to take this matter in hand. I am glad to say the officials are now fully alive to the importance of this question, and it is to be hoped that we may shortly see better arrangements established, and that ocean steamers will be able to go alongside and discharge and load their cargo without the wasteful expense and the delay of lighterage.

## UGANDA.

The results obtained in Uganda are quite the largest and in some ways the most satisfactory of any new cotton field in the Empire. Unfortunately, owing to lack of sufficient capital, the Association were unable to undertake any direct work, and had to confine their energies to representations to the Colonial Office and communications with the Uganda Company. Later on, in 1906, when the British East Africa Corporation was formed, the Association took up shares in this company, and two of the Council joined the Board of Directors, and the Corporation were appointed the agents of the Association for East Africa and Uganda. Although this was perhaps the most satisfactory arrangement which could have been made, it cannot be regarded as an ideal one. Every commercial company must naturally look principally to the earning and payment of dividends, and it is not to be expected that they should regard cotton growing entirely from the Association's point of view. Although the affairs of the Association must as far as possible be run on business lines, in order to avoid financial disaster, at the same time the Council consider—and rightly—that the establishment and extension of cotton growing must be paramount to the earning of dividends. In other words, the Association must and do take risks which ordinary commercial companies would have to refuse.

In the early days large quantities of seed of various varieties were distributed indiscriminately, and in any shipment of Uganda cotton one could find cotton of every variety and nature mixed together, and in one single bale one would find cotton varying from ½ to 1½ inches in length. Representations have been frequently made by the Association that it was of the greatest importance that there should be a properly equipped Department of Agriculture, and that the distribution of seed for sowing must be under Government control. This is the most vital question in connection with cotton growing, for unless the seed issued to the natives is sound in quality and pure in strain everything else is thrown away. One may have the most perfect climate and the most excellent soil in the world and the best methods of cultivation, but unless the seed sown is of good quality all these other advantages are wasted.

One of the difficulties was to find trained experts to work in an Agricultural Department, and the Association have frequently urged the Government to establish a system of scholarships whereby young men who have had a good scientific training at home could subsequently obtain the necessary practical training in the various branches of tropical agriculture.

Even to-day Uganda cotton is by no means satisfactory in quality, and one of the worst defects is the large amount of stained and weak cotton which not only seriously affects the selling price but also renders it more difficult of sale. Short-stapled cotton which is regular in length and quality will often fetch a higher price and be easier to sell than longer-stapled cotton which contains a considerable proportion of stained and short fibre. It is of the very greatest importance to the spinner to be able to depend on the regularity of any particular mark or brand of cotton which he may buy, and I am sorry to say that Uganda cotton varies as much as 1d. to 2d. per pound in value. As I previously mentioned. Lagos cotton does not vary one-farthing per pound between the best and the worst, and although the fibre and staple of Uganda is very much superior to Lagos cotton, a good deal of it has to be sold at a lower price.

As regards the stained cotton, it is still a moot point as to what is the actual cause. It may be the result of climatic conditions, or it may be caused by careless picking, or by bad handling after it is picked. It is probable that all three causes contribute to the unsatisfactory result. I am glad to say that in 1912 and 1913 the cotton was decidedly better in quality, and as there happened to be a scarcity of this particular type of cotton it met with a ready sale. It is too soon yet to decide as to the quality of the present crop, but I should like to utter a word of warning as to the danger of introducing more new types of cotton. Uganda cotton of the old type at its best is very much liked by spinners and commands a ready sale and if the defects could be eliminated it has a great future before it, as America seems less and less able to produce this particular type of cotton running from $1\frac{1}{16}$th to $1\frac{3}{16}$th inches in length. It is by no means an easy matter to get spinners to change their quality and to try new growths, and frequently this can only be done by accepting a lower price. Now that we have created a regular demand for Uganda cotton it would be dangerous to change the type, for it would completely upset the market, and all the work of creating a demand would have to be done over again. In any case I should strongly urge that one should proceed very slowly and tentatively in the matter. If the existing defects could be eliminated, one could not wish for better cotton than what I may term the 1912 to 1913 type of Uganda cotton.

One subject which has given a good deal of trouble is that of Cotton Rules, regulating distribution of seed, cultivation and marketing of cotton, etc. Time after time the Association have drawn the attention of the Colonial Office to the necessity for regulations, not only in Uganda but also in other Colonies, for the control of the industry. Unfortunately the Cotton Rules first proposed for Uganda were quite impracticable, and would have been an unnecessary interference with legitimate commercial enterprise with no corresponding advantages. It was actually suggested that cotton should be classified into at least a dozen different grades, although there was not a single individual in the country capable of grading cotton into even four or five grades It was also proposed that all shippers should be compelled to use the same marks or brands, which would have had the effect of placing those who really took trouble to keep their cotton clean on the same level as those who handled it carelessly. Mainly owing to representations from the Association, the Cotton Rules have been redrafted on a better basis.

The first record of exports of cotton from Uganda was in 1904, when 54 bales were shipped. Since then the industry has advanced by leaps and bounds, as will be seen from the following statement showing the crop of each year in round figures:—

| | | |
|---|---|---|
| 1906 | 500 | bales. |
| 1907 | 2,000 | „ |
| 1908 | 4,000 | „ |
| 1909 | 5,000 | „ |
| 1910 | 12,000 | „ |
| 1911 | 20,000 | „ |
| 1912 | 29,000 | „ |
| 1913 | 26,000 | „ |

It is understood that the falling off in 1913 was due to some mistake about the issuing of seed, and that for some unexplained reason a large quantity of seed for sowing was distributed too late.

So rapid an increase in a new industry naturally caused innumerable troubles, difficulties of transport, difficulties of finance, and so on. Further, there was a large amount of reckless competition, and the buying price was raised to such a point that many of the buying companies lost money. The Association did all in their power to promote a buying agreement, for they recognised that in the long run inflated prices would do no good to the industry. It is difficult for native farmers to understand the fluctuation of price in the markets of Europe, and they would certainly be discouraged when the price had to be brought down again to an economic basis.

As regards financing, the Association gave all possible help by very large loans to the British East Africa Corporation and others, and they did all in their power to ensure quick sales and prompt cash returns for any cotton consigned to them. They also took up the question of transport very seriously at the Colonial Office, and the representations they made have been most effective. A railway has been constructed from Jinja on Lake Victoria to Namasagali on Lake Kioga, and there is now a better supply of rolling-stock on the Uganda Railway and more steamers and barges on both Lakes. The Government authorised a loan of £500,000 for the construction of roads and the improvement of transport facilities generally, and more recently the Government have arranged to assist in the issue of a further loan of £3,000,000 for the provision of better transport facilities in our East African possessions.

## NYASALAND.

Nyasaland is no exception to the general rule, that one of the greatest difficulties in establishing cotton growing in a new country is the absence of economical means of transport. In the early days cotton had to be conveyed, mostly in head loads, from Blantyre and elsewhere to the Shire River. Thence it was conveyed by barge down to the Zambesi and to Chinde. Frequently for many months together river transport was impossible. At Chinde it was transhipped into ocean-going barges and conveyed to Beira, where it was loaded on to the ocean steamers. It is surprising that in face of these difficulties any cotton was grown at all. A railway was first constructed between Port Herald and Chiromo, and the extension to Blantyre was completed in 1909. Later on, thanks very largely to the efforts of Sir George Fiddes, arrangements were made for the extension of the railway from Port Herald down to the Zambesi, which would entirely eliminate the difficulties of low water in the Shire river. Towards the cost of this the Association and their friends raised £36,200 of the required capital, and the work is now rapidly being pushed on. Negotiations are also proceeding for the construction of a connecting railway from the Zambesi to Beira, and when this is completed it will be possible to load cotton on to trucks at Blantyre, which will convey it direct to the steamer at Beira. This railway will eventually become one of the main trunk lines in South-East Africa, and its extension to Lake Nyasa and North-Eastern Rhodesia is only a question of time. The Association have never missed an opportunity of impressing on the Colonial Office the great importance of economic transport for the produce of Nyasaland.

Like Uganda and other Colonies, there was no Agricultural Department in Nyasaland, but in consequence of representations from the Association an expert was appointed in 1904, and to-day Nyasaland has a small but efficient Agricultural Department which is doing excellent work.

The quality of the cotton grown in Nyasaland is generally excellent in quality, and as there are two types of country, the Lowlands and the Highlands, so also are there two types of cotton. Generally speaking, in the Highlands cotton of Upland American type has been most successful, and after several years of work the Nyasaland Upland type was definitely established in 1909. It is not very long in staple, but is very clean and silky, and Nyasaland seed has given very good results in other countries. It fetches as a rule from about 1d. to 2½d. over Middling American. In the Lowlands, cotton of the Egyptian type has given the best results, and Abassi better than Affifi. It is, however, possible that even more satisfactory results might be obtained with long-stapled American cotton of the Allen's or Griffin type.

In the early days the Association had no branches of their own, but the African Lakes Corporation were appointed as their agents, and a very large amount of financial assistance has been given by us to a number of European planters to enable them to start cotton growing. The Association lost a good deal of money through these advances, but on the whole the results have been quite satisfactory from a cotton growing point of view. The establishment of an entirely new industry is a difficult matter, and especially so in a tropical country.

In 1906 an attempt was made to establish cotton growing as a native industry, and the Association made arrangements for the African Lakes Corporation to purchase all the cotton grown on their behalf. This industry did not progress very rapidly at first, and in 1910, in consequence of representations from the Government, the Association decided to establish their own branches, without, however, interfering with the friendly relations which existed with their agents. A ginning factory and buying station was established at Port Herald, and a powerful hydraulic press was erected so as to help the planters in obtaining low rates of freight. Two other ginning and buying stations have since been established at Chiromo and Vua (on Lake Nyasa), and the Association have just purchased another ginning factory at Fort Johnston, which would otherwise have been closed owing to the company which owned it going into liquidation. The Association continue to give considerable financial assistance to the planters and others, though probably in the future the system of financing crops will be discontinued, and cash advances against actual cotton will take its place. Nyasaland is only a small country, and very large results cannot be expected, but it is satisfactory to be able to record that the crop increased from 192 bales in 1903 to 1,444 bales in 1906, and the 1912 crop amounted to 6,800 bales.

There are also considerable cotton possibilities in North-Eastern Rhodesia, which geographically is part of Nyasaland. The Association is working in co-operation with the North Charterland Exploration Company, and is giving considerable financial assistance to planters and others. Cotton cannot, however, ever become a big question in this country until better means of transport are provided.

## ANGLO-EGYPTIAN SUDAN.

When the Association commenced operations there were no economic means of transport to the interior of the Anglo-Egyptian Sudan, but as soon as the Suakin-Berber Railway was completed in 1906 the Association offered to do what they could to assist, but they were informed that their help was not required, and no further steps were taken in the matter. In 1909 the Egyptian cotton crop was an absolute failure, and it became evident that one must look elsewhere for an addition to the supply of cotton of the Egyptian type, and the Association again began to make inquiries as to the possibilities of the Sudan. On October 13th, 1910, Sir William Mather gave an important address at the Manchester Town Hall on the cotton possibilities of the Sudan, and the Association then decided to take up 5,000 shares in the Sudan Plantations Syndicate, which was far and away the most important cotton growing firm in the Sudan. The Association appointed a representative to join the Board of Directors of the Syndicate, and subsequently took up a further 4,000 shares.

The Sudan Government had commenced an important practical experiment at Tayiba to prove whether cotton could be grown on the Gezira Plain with irrigation between July and March, and they wisely handed over the management to the Syndicate. In view of the great importance of the question, and with the object of acquiring more definite information on the subject, the Council decided in 1911 to send out a deputation, and representatives of the Association visited the Sudan in January, 1912. The Deputation were most deeply impressed with the cotton possibilities of the Sudan, and they were particularly struck with the excellent quality of the cotton which was being grown there. Their report has been published in full, but the results of their investigations may be summarised as follows:—

1.—TOKAR: Good possibilities of producing 10,000 to 20,000 bales of cotton of fair quality in the immediate future.

2.—KHARTOUM AND NORTH: Moderate prospects of producing 5,000 bales or more of high-class Egyptian cotton in the immediate future, with further possibilities of increase if an earlier maturing and more robust type of cotton can be established.

3.—GEZIRA: One of the finest cotton propositions in the world. There seems to be no reason why in the next few years one should not raise annually 50,000 bales or more of really high-class Egyptian cotton, with the prospect of the production increasing to 250,000 bales within 10 or 15 years, and with further possibilities later on of a production of 1,000,000 bales or more.

4.—RAIN-GROWN COTTON: The prospects in the Sudan of producing very large quantities of cotton of American type are most encouraging and in some ways better than those in either Northern Nigeria or Uganda. There is land enough to grow millions of bales, but the future must depend on sufficient population, efficient Government supervision, and the requisite commercial assistance for buying and ginning.

5.—GEDAREF AND KASSALA: There are considerable possibilities in these districts for both rain-grown and irrigated cotton.

There is not the least doubt that the Tayiba experiment was an eminent success, and the Council therefore decided to press the Government to do all in their power to push on the development of the Gezira Plain with all possible speed. The establishment of cotton growing is a slow business at the best, and many years must elapse before any new field can be expected to produce 100,000 bales annually even under the most favourable conditions. Considering that Lancashire consumption is over 4,000,000 bales per annum, and considering also that the world's demands for cotton are growing rapidly every day, it is evident that the question is one of the greatest urgency. The Association were convinced that the Gezira Plain was the only new field where one might expect an appreciable quantity of high-class cotton in a reasonable time, and on January 23rd, 1913, a deputation from the Association waited on Mr. Asquith and urged that the Government should guarantee the interest on a loan of £3,000,000 to be raised by the Sudan Government for the construction of irrigation and other works in the Sudan. The Government soon afterwards introduced the necessary legislation in Parliament, and it is hoped that the loan will shortly be issued and operations commenced with the least possible delay. We can at any rate congratulate ourselves on the fact that Lord Kitchener has taken up this important question with his well-known zeal and energy, and I think we can safely leave the matter in his hands.

## SUMMARY.

I now propose to sum up as shortly as possible the results of our twelve years' work. We have spent £170,000 on experimental work, and although this may seem a large sum to devote to this, I think we can rightly claim that the results justify the expenditure. In the first place, we have aroused the interest of the whole Empire in the possibilities of cotton growing, and we have started a movement which will go on for ever. Further than that, during the last twelve years a really appreciable quantity of cotton has been grown in new fields where little or no cotton was grown before.

In 1903 the amount of cotton grown in new fields in the British Empire amounted to only 1,900 bales, valued at £29,000. It is estimated that in 1913 78,800 bales were produced, worth £1,170,100, and since we commenced operations in 1902 no less than 360,640 bales have been produced, to the value of £5,195,100. We have also acquired most valuable experience, and we have got a staff and organisation fully capable of dealing with the work. While not losing sight of the object for which the Association was formed, everything is run on business lines as far as possible, for it is essential that we should be able to pay our way, as otherwise we should have to abandon the work. I think it will be generally admitted that it would be a misfortune for Lancashire, and indeed for the whole Empire, if the Association had to suspend or even to curtail its operations in any way.

In order to give you some idea of the magnitude of our business, I may mention that 47,466 bales, to the value of £661,227, passed through our hands in 1913, and at the present moment we have over £250,000 advanced against cotton. We do all we can to help planters and others by financing and superintending the sale of their cotton, and we make a point of obtaining the very best price possible. For these services we charge a small commission, which brings us in a substantial sum towards our standing expenses. We also supply machinery, plant, baling material, seed, etc., on easy terms of repayment, and we are now conducting a large banking business in financing cotton, seed, machinery, etc.

We also render valuable services to Agricultural Departments and others in reporting on samples and advising as to their suitability for the market, and we are always willing to help anyone who requires definite information as to cotton or cotton growing.

What perhaps will give the best idea of the magnitude of our business is the fact that we received and despatched no less than 62,113 letters in 1913, or an average of 207 per working day.

We also hold a large number of shares in cotton growing companies, and have our own representatives as Directors to assist in the management; and, including the companies in which we are interested or which have been formed with our assistance and our own capital of £480,000, the total amount of capital raised for cotton growing under our auspices now amounts to £1,125,000. The work, however, continues to grow rapidly, and the provision of large sums of additional capital is a most pressing question.

I think therefore the Association can claim that they have more than justified their existence, for they have definitely proved that the British Empire can produce the cotton which Lancashire requires. The quantity is, of course, at present small in comparison with Lancashire's total consumption, but the rate of progress we have achieved is infinitely greater than was the case in the early days of cotton growing in the United States of America. A great statesman, in drawing attention to the future importance of our Colonies, impressed on his hearers the necessity of thinking Imperially. I think the Association can claim with pride that they have done even more than this, for they have been acting Imperially, and have started one of the greatest Imperial movements of modern times, and one which must be for the ultimate welfare of the whole of the British Empire.

Before I conclude, I should like to express on behalf of the Association the grateful thanks we owe to His Majesty's Government for the generous treatment and for the valuable assistance they have always given us, no matter which party was in power. The British Cotton Growing Association knows no politics. It is impossible to mention everyone by name, but I must take this opportunity of expressing our most grateful thanks both to Mr. Harcourt and to Lord Emmott for the deep interest they have taken in the work and the invaluable help they have given us. Nor can I sufficiently express our gratitude to the other officials both at the Colonial Office and in the Colonies, for without the assistance and sympathy they have always so readily given our work would have been impossible. Finally, I should like to express our grateful thanks to Professor Dunstan and the staff of the Imperial Institute for most valuable advice and assistance on many occasions, and particularly to him as President of this Conference for affording us an opportunity of laying before you this summary of our somewhat arduous labours during the last twelve years.

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[NOTE.—This paper is reprinted from plates supplied by the British Cotton Growing Association, and the appendix referred to on p. 139 has not been reproduced here.]

## THE WORLD'S DEMAND FOR COTTON, AND INDIA'S SHARE IN MEETING IT.

By Arno Schmidt.

*Secretary of the International Federation of Master Cotton Spinners' and Manufacturers' Associations.*

The cotton industry of the world has, during the last ten years, been suffering from a scarcity of raw material. This scarcity has frequently been so pronounced that mills in all parts of the world have been obliged to curtail production at one time or other. At a meeting of the International Committee held early in June, 1914, in Paris, it was generally admitted by the representatives of fifteen countries that the cotton spinning industry all the world over had never been in such a depressed condition as at present, and it was stated by the members of the Committee that many English and Continental spinning mills are curtailing their working hours. This slackness of trade is partly due to the Balkan War and the Chinese Revolution, but very largely also to the high price of American cotton, which rules the prices of all other cottons.

The primary cause of short-time working undoubtedly arises from the fear that the world's yearly supply of cotton will not be sufficient to meet the yearly demand. During last season we were told that the American cotton crop would be about 13,500,000 bales, whilst it is recognized that 14,500,000 bales of American cotton are required annually. This probable scarcity caused an increase in the price of the raw material and of the finished article, and a falling-off in the demand for manufactured goods. It must be remembered that by far the vast majority of the people in the world, the poorest who have no choice but to use cotton clothing, have only a very small fixed amount per annum to expend on clothing, and it makes a great difference to them, in the quantity of clothing they can afford to buy, whether cotton is 6d. or 8d. per lb.

### What are the Possibilities of extending Cotton Cultivation in the World?

*Africa.*—At one time the hope was entertained that Africa would solve the problem of supplying the cotton-spinning industry with its ever-increasing requirements, but after ten years' work in that continent it has been proved that, in consequence of the absence of the requisite training of the people, the comparative scarcity of labour, the absence of transport facilities, the necessarily slow development of research work, and of the unwillingness of the people to work longer than is absolutely necessary to keep their few wants supplied, developments in those parts must be slow. Perhaps the next generation will reap the benefit of the present pioneer work. Most valuable work is being carried on, not only by the British Cotton Growing Association, but also by the German, French, Italian, and Portuguese colonial cotton growing associations. The very existence of these associations is a proof of the earnestness with which this question of increasing the supply of cotton is being handled.

*Egypt.*—Egypt is limited in its cotton crop by the comparatively small area that can be irrigated; Lord Kitchener is doing his utmost to reclaim some considerable stretches of waste land, and bring it under irrigation. Egypt now produces about one million bales, of 700 lb., per year, but there has been during the past ten years a falling off in the yield per acre.

*Anglo-Egyptian Sudan.*—The possibilities in the Anglo-Egyptian Sudan are certainly very great, but it will probably taken fifteen years for that country to produce half a million bales. In view of the threatened shortage of long-staple cotton from America, owing to the advance of the boll-weevil into the Sea Island tract, the irrigation scheme in hand in the Sudan should be accelerated, and money should be liberally supplied for the work.

*United States of America.*—Cotton planters of the United States of America, and others interested in land, often assure us there is no need to look elsewhere for the supplies to meet the increasing wants of the cotton industry. I would say, in reply to this contention, that it would be unwise for the world's spinners to depend upon one source of supply only, especially when, as in the case of the United States, there is a climate which, judging from the alarmist reports issued every year, seems to be the most uncertain in the world. Further, the cotton districts in the United States are suffering severely from lack of labour. Several experts who have recently visited the country state that in 1911, when the cotton crop of the United States reached 16,000,000 bales, much more was grown, but that it had to be left to rot in the fields, as there were no people to pick it. Some authorities maintain that wages have increased of late to such an extent that the growing of cotton is becoming unremunerative, and that unless cotton can be sold by the planter at 6d. per lb., which means that the spinners will have to pay considerably more, cotton cultivation in the United States of America will decline. As an example of the recent wages paid in the United States I am able to state that, whilst the "piece rate" for picking in Texas usually began at 50 to 60 cents per 100 lb. of seed-cotton, rising later, as the crop became thinner and more difficult to gather, to over 100 cents, during the early part of last season pickers could not be got in Texas below 70 cents, and the 100 cents rate was reached very quickly. If we remember that it takes about 300 lb. of seed-cotton to make 100 lb. of lint cotton, the cost of picking works out at 1½d. per lb. Under these conditions, countries outside the sphere of such high wages seem to have an excellent opportunity of competing with the United States of America, even if the climatic conditions are not as favourable. Experts seem more and more of the opinion that cotton growing in the United States will only be remunerative in the case of long-stapled cottons, such as are produced in the Mississippi Delta, whose value is much above the ordinary type.

These considerations seem to justify the prevalent assumption that the limit of the cotton crop of the United States has been reached. It is true that owing to the excellent organization of the United States Department of Agriculture the yield per acre is gradually increasing; but if labour cannot be found to harvest the cotton, the full advantage of its activity cannot be realized. So long as no efficient mechanical cotton picker is invented (and so far the results obtained have not been satisfactory), the cotton crop of the United States will probably not far exceed 16,000,000 bales. In the event of an efficient mechanical cotton picker being put on the market, it is doubtful if many planters would be able to afford to purchase it. The tendency in the States is to split up the large plantations into small holdings, and the small farmer has not the capital with which to buy such a machine. We must not leave out of consideration the boll-weevil scourge which is devastating vast stretches of territory. It is stated that in five years' time the Sea Island cotton districts will be attacked, and that the farmers there will be forced to grow early maturing varieties of cotton, which are largely of short staple. It is for this reason that every effort should be made to complete the irrigation works in the Anglo-Egyptian Sudan. Egypt and the Sudan will be called upon to make up for the shortage that will result in the supply of long-staple cotton, when the Sea Island districts have become a prey to the ravages of the boll-weevil.

*South America.*—The Republics of South America are already suppliers of cotton to a small extent (500,000 bales), and when better means of transportation are established, and the population increases, it is probable that Brazil and Peru will furnish large quantities of cotton. But for a generation or two this cannot happen. At present the unsettled financial condition of these Republics prevents development.

*Asiatic Russia.*—Asiatic Russia supplies the Russian cotton industry with one million bales of cotton of 500 lb., quite equal in quality to Middling American. The principal cotton-growing districts are Ferghana, Syr Darja, Semiretschenck, Samarkand, and the Transcaspian territory. The danger of the increasing evaporation of moisture from the soil in Turkestan, the lack of transport communications for the importation of fodder and food crops, as well as for the exportation of the cotton crop, and the lack of labour, are the principal reasons why the extension of cotton cultivation in Asiatic Russia is bound to be slow. The average wage of a labourer is 4s. per day; this alone is enough to prevent any large extension.

*China and Korea.*—It is estimated that China and Korea produce about one and a half million bales of cotton of 500 lb., but very little is known as to the possibilities of extension. The quality produced is very low, and the cotton is adulterated with over 15 per cent. of water and sand. The unsettled political state of China is bound to impede developments there.

*Turkey.*—Turkey produces about 100,000 bales of cotton per annum. Owing to the massacres which have recently taken place in Asia Minor, the country suffers severely from lack of labour, and even if the projected works of irrigation are successfully carried out, it will be a long time before appreciable quantities of cotton can be exported.

*India.*—After considering the possibilities of the extension of cotton cultivation in all these countries we come to India, which possesses an excellent network of railways, has a hard-working population, 90 per cent. of the 315,000,000 being born agriculturists, and in which cotton has been an important crop from time immemorial. It is true that crops in India are largely dependent on the monsoons, but it is equally true that the climate of India is no less favourable to cotton growing than that of the United States. Besides, the Government has developed a wonderful system of irrigation, especially in the North; and the Indian ryot, taking him as a whole, is a steady, plodding worker, who has begun to appreciate the advantages resulting from an increased income. This is a very important factor. The Indian ryot has discovered that well irrigation makes cotton growing profitable; indeed, in Madras and the United Provinces the number of wells constructed by the cultivators in recent years may be said to represent the savings that have resulted from the increased profits on cotton cultivation. These wells are the best insurance against famine.

I now turn to the question of the demand for raw cotton. It has been said that a demand for cotton goods is one of the first signs of civilization.

Mr. Alexander J. Kusnetzoff, one of Russia's leaders of the cotton industry, stated at the Seventh International Cotton Congress at Brussels (1910) that of the 1,500,000,000 inhabitants of the earth, there are only 500,000,000 completely clothed, whilst 750,000,000 are partly clothed, and 250,000,000 do not possess any clothing whatever, and that in order to provide clothing for the whole of humanity, at least 42,000,000 bales of cotton, or 15½ lb. for every human being, were annually required.

The world's consumption of cotton has increased from 1909 to 1913 at the rate of almost one million bales per annum! These figures are based upon the statistics issued by the International Cotton Federation, compiled from the individual returns of the spinners.

Russia has increased its consumption of cotton as follows:—

| | | Consumption—lb. (English) | | | Consumption—lb. (English) |
|---|---|---|---|---|---|
| 1855 | ... | 54,195,000 | 1901 | ... | 603,371,000 |
| 1860 | ... | 90,325,000 | 1902 | ... | 541,950,000 |
| 1870 | ... | 144,520,000 | 1903 | ... | 794,860,000 |
| 1875 | ... | 162,585,000 | 1904 | ... | 726,213,000 |
| 1880 | ... | 307,105,000 | 1905 | ... | 614,210,000 |
| 1886 | ... | 361,300,000 | 1906 | ... | 755,117,000 |
| 1890 | ... | 252,910 000 | 1907 | ... | 751,504,000 |
| 1894 | ... | 444,399,000 | 1908 | ... | 794,860,000 |

The weight of cotton cloths produced on power looms and consumed in India has increased from 536,960,200 lb. in 1896-97 to 988,027,318 lb. in 1912-13. The consumption per head of the population in India is equal to 3·63 lb., or roughly 14 yards. The clothing of the people of India requires at present 3¼ million bales of cotton (including waste), but every additional yard used per head of the population represents an increase of about 232,000 bales of 500 lb. each. The increased prices which the cultivators of India are receiving, not only for their cotton, but also for other produce, are bound to place them in an improved financial position, which will undoubtedly lead to an increased expenditure on clothing.

But besides Russia and India there are other vast countries, such as China, Africa, Central Asia, etc., all of which will demand increasing supplies of cotton clothing.

Consideration must also be given to the fact that cotton has entered into many new uses in Europe. It is in great demand for the making of motor-car tyre covers, bagging, ropes, aeroplane cloth, etc.; and, as a result of the discovery of the mercerizing process, in the manufacture of certain classes of goods, cotton has replaced silk to a considerable extent. As soon as the fashionable ladies of Europe revert from the "hobble" skirt to the fuller skirt—and fashion seems to be developing in this direction—large additional supplies of cotton will be wanted. Spinning and weaving machinery has extended to meet the increased demand, and this extension will continue; but the cotton industry must obtain an annual increase of about 1,000,000 bales of raw material.

As a further example of the growing consumption of cotton by the European countries, I may state that, according to Government figures, the consumption per head of population in Germany has increased from not quite $\frac{3}{4}$ lb. in 1840 to 16 lb. in 1912. Whilst the figures for the consumption of wool show a decline, the cotton consumption is more than twenty-five times bigger than 70 years ago.

This enormous and ever-increasing demand for raw cotton secures the cultivator for many years to come a remunerative price for his cotton crop, and not only the Government of India, but every other Government is fully justified in encouraging the cultivation of cotton in face of this regularly increasing demand.

It is not yet twenty years since Middling American cotton was 3d. per lb., but for the past few years it has rarely fallen below 6d. per lb.

The demand outside India for the cotton grown there comes principally from Japan and the Continent of Europe; Lancashire and the United States of America are only small consumers. On the European Continent Indian cottons of superior qualities are being employed more and more to take the place of American cotton, and the statistical compilations of the International Cotton Federation, showing the stocks of cotton in the mills of the whole world on March 1, 1914, indicate the increased use to which Indian cotton has been put during the last year.

The question of the cotton supply should be looked upon from an international point of view, as all the nations are interdependent.

## The Production of Cotton in India.

The International Cotton Federation has at all times urged, in the first instance, the growing of larger quantities of cotton in India. Although the question of quality has been looked upon as a point of secondary importance, yet it is one which would naturally receive the attention of the growers.

The results achieved in regard to quality in Madras, in the Punjab, in Sind and Guzerat are very promising, for taking these together we have had during last season a crop of some 300,000 bales which are of a quality equal to Middling American, though, owing to defective picking and mixing, the price obtained for these cottons may not have been as high as it might otherwise have been.

It is a mistaken idea to suppose that India can produce only coarse and short cottons. It is an historical fact that India used to produce cotton from which the finest kinds of tissues were woven, and it is only through mixing of different cotton varieties and the lack of scientific supervision that the Indian cottons have deteriorated. I am, however, able to state the experience of many cotton spinners to the effect that the Indian cottons have improved again of late years in quality, no doubt due to the activities of the agricultural experts, and there is every reason to hope that further progress will be made in this direction.

The tour which I undertook during last winter through the Indian cotton-growing provinces extended to Sind, the Punjab, North-West Frontier Province, the United Provinces, Madras Presidency, Central Provinces, Burma, Assam, and part of the Bombay Presidency. Thanks to the excellent arrangements made by the India Office, I was able to make a pretty exhaustive survey of the conditions in the comparatively short time of five months. I will content myself here simply with drawing attention to the salient features of each province, and refer those of you who are specially interested in the question to the report which the International Cotton Federation will issue in a few days.

*Sind.*

The most interesting development arises from the formation of a syndicate of Bombay millowners, which has started operations as the result of a suggestion I made four years ago on the occasion of my first visit tc India. This syndicate acts as a buying agency for the purchase of cotton grown from American seed, which the Deputy-Director of Agriculture has introduced amongst the cultivators in Lower Sind. Unfortunately, this year, owing to unexpected rains in August, this American cotton has suffered severely, almost one-third of the plants hâving been washed out of the ground, and the colour of the lint has been considerably damaged in the remaining plants. Instead of having a crop of 800 bales of American cotton from Lower Sind, only 450 bales have been harvested. This syndicate has also erected a ginning factory in Upper Sind, but there the cultivation has suffered from a lack of water in the canals. The future of Sind as a cotton-growing area depends largely on the supply of water in the canals, and it has been proved that unless the construction of the Rohri Canal, a project that has been before the public for about thirty years, is undertaken, Sind cannot be relied upon as an annual supplier of large quantities of cotton. It is a great pity that this district, which is very similar to Egypt, is withheld from producing good cotton owing to the impasse in connection with the canal project.

The indigenous Sind cotton is short, but is much appreciated on account of its whiteness.

*Punjab.*

The outstanding feature of this province is that this season from 25,000 to 30,000 bales of American cotton have been grown in the Lyallpur district. This cotton originally came from Dharwar, but experts agree that the staple and colour have improved since it has been taken into the Punjab. The great drawback is that the ginners who purchase the cotton from the cultivators try to mix the local cotton with this Lyallpur-American cotton in the hope of cheating the buyer. The effect is that this cotton mixture is not sold at the price it would command if it were kept pure and that when the seed is used in the second year for sowing purposes the mixture has already taken place. It is of the utmost importance that the Department of Agriculture of the Punjab should undertake a wide distribution of American seed and confine it to certain villages. The more that cotton of one variety is grown in a district the more difficult becomes the task of mixing it with others. In this connection I might say that one of the characteristics of the Indian is a bent for gambling. No one else in the world is so given to speculating and gambling as the Indian, and although he may have been found out nine times in some underhand practice, he will persevere and try the tenth time in the hope that he will not be detected.

The licensing of ginning factories would undoubtedly be a remedy for this mixing.

The Punjab Government has undertaken extensive irrigation works, and besides those canals already supplying water to the northern part of the Punjab there will be inaugurated at the end of this year the Lower Bari Doab Canal, which will supply water to a large tract of country where the prospects of growing good cotton, Lyallpur-American, are excellent. The land is level and, therefore, most suitable for irrigation, and the clearing will cost comparatively little.

The International Cotton Federation has received the offer from the Punjab Government of a free lease of 7,500 acres of cotton land in the Lower Bari Doab Canal Colony for the purpose of establishing a model cotton plantation and a buying agency. The special features of this undertaking are: Intensive cultivation will be introduced; American cotton, similar to that grown in Sind and the Punjab, will be grown; pure strains of seed will be distributed; and cotton will be bought from the surrounding districts at a premium made known at the time of the planting season. The land has been offered free for twenty years, and in the event of more than 10 per cent. being earned, the surplus of profits above that figure will be returned to the Government, thus ensuring that the Indian cultivators will not be exploited. The undertaking is to be an educational movement, for the good of India, and not primarily a money-making venture.

### *North-West Frontier Province.*

There are two kinds of cotton grown here. One has a staple 1 in. long, whilst the other measures $\frac{5}{8}$ in. The former is grown on land flooded by hill streams, whilst the latter is grown on canal-irrigated tracts. Unfortunately, the ginning out-turn of this cotton is only 25 per cent., but there is no reason why it should not be improved by seed and plant selection. As in the Punjab, so in this province, the mixing of two different kinds of cotton is going on. In both cases the ginners, who are the first buyers, and not the growers, are the culprits. It is high time that it was realized in India that the shortest fibre in a mixture of cotton decides the price of the whole mixture, just as the value of a chain may be gauged by the strength of its weakest link. The growth of cotton in this province has more than doubled during the last five years, but the possibility of extension is not very great. I recommended in this province the establishment of a cotton market with a Government grader, such as there is at Tokar, in the Anglo-Egyptian Sudan.

### *United Provinces.*

In the Western Circle a white-flowering cotton with a ginning percentage of 39 to 40 has been largely introduced and gives a very remunerative result to the farmers. This cotton is very short, but owing to its high ginning out-turn is very remunerative. A longer cotton, of American origin, Buri, $\frac{7}{8}$ in. long, has been introduced as an experiment and promises well. It will be a contest as to whether it will be more remunerative for the farmer to grow the short or the longer cotton.

Round Cawnpore, an American variety is being grown, and 200 bales of this were bought last season by a Cawnpore millowner at 6½d. per lb. The ordinary cotton round Cawnpore is very short Bengal. There is urgent need for the work of an additional agricultural expert for Bundelkhand, where the conditions are entirely different from those in the Cawnpore area, the soil and climate of Bundelkhand being almost identical with those of the Central Provinces. In Bundelkhand has been inaugurated during the last decade an extensive canal system, but whereas in 1904 it had 160,000 acres under cotton, only 90,000 were cultivated last season with cotton. This is all the more strange as all the other districts of the United Provinces have gradually increased their cotton acreage. The Department of Agriculture holds the opinion that Bundelkhand offers a good future for the growing of cotton.

*Central Provinces.*

The organizations which assist the Department of Agriculture, and have been created by it, are excellent. Agricultural Unions and Co-operative Agricultural Societies attend to the distribution of cotton seed, and it is probably due to the excellent organization of the Department of Agriculture of that Province that it is now the second largest cotton producer of India. Since 1902, when the activities of the Agricultural Department started, the area under cotton has increased by almost 900,000 acres. The cotton grown generally is short, about ½ in. long, but the quantity is large and ever increasing. Cambodia has been tried with enormous success in Chanda, on the new Government farm, under tank irrigation; it not only yielded well, but produced a lint that has been spoken of by a Cawnpore millowner as "the best cotton grown in any part of India." The Central Provinces are the new home of Buri cotton, for it is from here that the United Provinces and Assam have received the seed.

It is unfortunate that the good reputation which the Agricultural Department is endeavouring to gain for the cotton raised in the Central Provinces and Berar is suffering largely from the malpractice of watering the ginned cotton prior to pressing. At all the most important centres one can see hose-pipes being used freely, say half an hour over 100 loose bales, and, in spite of the remonstrances made by the spinners of the world, it is surprising that the Government of India cannot see its way to suppress this practice, which has been termed a "fraud" by the Secretary of State for India.

### *Madras.*

As regards Madras, an improvement has undoubtedly taken place in the quality of Northerns, which the Agricultural Department has improved by plant selection. A slighter improvement has taken place in the Western cotton, but, unfortunately, owing to lack of staff, hardly any work has been carried on by the Department of Agriculture for the improvement of Cambodia. When this Cambodia was introduced it had a ginning out-turn of 44 per cent., now it varies from 33 to 35 per cent. With plant selection and importation of new supplies of seed good work might be done by agricultural experts. Spinners complain very much of the falling-off in quality of Cambodia cotton. This cotton has 1 in. staple, and is a phenomenal yielder, as 500 lb. of lint per acre is quite a common crop. As Indian cotton generally yields only 100 lb. per acre, it will be readily understood that many ryots are using all kinds of unsuitable land for the purpose of trying this wonderful cotton. Unfortunately, the Co-operative Credit Societies in Madras are not yet sufficiently developed to take up agricultural work. A great improvement would take place if the Department of Agriculture were to sell selected seed on credit in this Presidency.

### *Burma.*

So far little attention has been paid to Burma cotton. The Government state that about 47,000 bales are grown every year, but last year, and again this year, between 70,000 and 80,000 bales were exported. Burmese cotton, as now marketed, is a mixture of long and short varieties.

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The long cotton has a staple of 1 in., is white in colour, and silky. It is known under the name of Bhamo cotton, and used to be exported to China. The Chinese insisted upon the different pickings being kept apart, but when about fifteen years ago mechanical ginning factories were started in Burma their managers were not so particular as to quality and insisted upon quantity, with the result that the mixing has continued, and even now no satisfactory difference is made in price for the different qualities or for clean-picked cotton. Three large European firms have formed a combine, and, in the absence of effective competition, the low prices paid by the combine to cultivators must result in a reduction in the acreage next year. One advantage has resulted from this combine, and that is that its buyers steadily refuse to accept any seed-cotton that has been watered.

Considerable quantities of a coarse cotton giving 50 per cent. ginning out-turn are grown on the sides of the hills in the Shan States and other hill districts, under perennial cultivation. The method of cultivation is to burn down the hillside and then put in cotton plants and allow them to stay for three years. By that time the soil has become impoverished, and the tribes then go to other tracts and start the same process afresh. Owing to lack of staff and railways the Agricultural Department has not been able to introduce more economic methods in these parts.

### *Assam.*

There is a small plantation in the Kamrup plain of Assam, where last year several acres of Buri cotton had been grown as an experiment. The results have been excellent. The spinner who obtained this cotton bought it at the rate of 7d. per lb. The result of this experiment has astonished the officials of the Assam Agricultural Department, who had previously declared that cotton could not be cultivated in the plains of Assam. The Lieutenant-Governor, Sir Archdale Earle, showed great interest in this new venture, and promised that the Agricultural Department should take up the question of cotton growing.

*Baroda.*

I was exceedingly pleased with the general conditions at Baroda, especially with the Government farm there, under the management of an Indian. Extensive areas are grown under Cambodia cotton, and the Dewan and his officials are evidently alive to the necessity of helping on the Department of Agriculture. Five hundred farmers met at Baroda on February 20 to hear an address from H.H. the Gaekwar on the advantages of Co-operative Credit Societies in relation to the improvement of the cultivation.

The Broach and Navsari cottons of Baroda have a world-wide reputation for their excellent qualities.

*Bombay Presidency.*

I did not visit, on this occasion, many parts of this Presidency, but I had previously made a thorough investigation. In the north of Bombay Presidency the Government have achieved very good work with regard to improved Broach cotton, and the Bombay millowners established, on the recommendation of the International Cotton Federation, a buying agency, guaranteeing a premium for cotton that had been raised from the improved seed. Unfortunately, last season difficulties arose, but it is hoped that the Government will undertake a stricter superintendence of the distribution of seed and the collection of the cotton from the small farmers.

In the south of Bombay Presidency, in the Karnatak tract, Dharwar and Gadag are the principal centres. At Dharwar we find the only saw-gins in use in the whole of India. Indian cotton is ginned, in general, by roller-gins, but here in Dharwar saw-gins are used for the purpose of separating the fibre of American cotton from the seed. Latterly the Dharwar American cotton has deteriorated, and the Government has introduced with success Broach and Cambodia cottons.

Bombay Presidency is the largest producer of Indian cotton, supplying over 29 per cent. of the total Indian crop.

*Conclusions.*

The outlook in general, as regards India as a large supplier of cotton, is most promising, but the Government will have to engage a much larger staff of farming experts. The few who are at present in the Government's employment are a great credit to the British nation, and are the most remunerative investment which the Government of India has ever undertaken. I can prove that in almost every province, through the instrumentality of these farming experts, additional millions of rupees are annually brought into the country.

The Government of India spends about £1 per thousand of the population on agriculture, leaving out veterinary expenditure. Comparisons with other countries show how absurdly small this outlay is. The United Kingdom spends £46 per thousand, Queensland £92·5, Austria £86·5, Prussia £62·5, United States of America and Canada a little over £36, France and Hungary about £27. The *Pioneer* of Allahabad, which supplied this information, in a leading article dealing with an address I gave before the Board of Agriculture, says this comparison is very instructive, and that no one can fail to see that State expenditure on agriculture in India is only in its infancy, and that an unanswerable case exists for its expansion.

On my journey I advocated the system of supplying seed on credit, the same as has been introduced by Lord Kitchener in Egypt. All the machinery exists for the collection of the value of the seed through the tax-collector. If this method were adopted in India, we would soon see the Department of Agriculture obtaining a monopoly over the supply of seed, and in this way the ryot would gradually free himself from the hands of the moneylender. The more general establishment of cotton markets, with Government graders, and possibly in some provinces the licensing of ginning factories, would be effective means of stopping the mixing of the various cottons, for not only is the purchaser cheated through this practice, but much greater harm is done when, in the following season, the mixed seeds are sown in the field. The watering of cotton should be made a penal offence.

I feel convinced that the introduction of such methods as I have suggested would enable India to supply in the near future, say in about five years, a cotton crop of 10,000,000 bales. Cotton is a crop that can be readily converted into cash at any time. It is a crop that requires a food or fodder crop as a rotation, and therefore does not interfere with the growing of food and fodder crops. Of course, the man who owns only half an acre must in the first instance devote his land to the raising of food crops. The cotton-seed cakes, or better, the meal of these cakes, form, in all agricultural countries, an excellent cattle food which is not yet sufficiently used in India. The meal can be conveniently packed in a small compass, and can be transported expeditiously by rail to famine-stricken districts when necessary. These cotton-seed cakes have found great favour in England and the United States, and one may justly look upon cotton quite as much as a fodder-producing plant as a fibre plant, seeing that the seed grains are the heaviest portion of the crop.

At present 5·9 per cent. of the gross cropped area of India is under cotton, whilst 79·6 per cent. is under food and fodder crops; even in famine years India exports foodstuffs. It must be remembered that cotton is a crop that can be warehoused for years without suffering in the least, and as I have shown at the beginning of my paper, there is very little possibility, owing to the ever-increasing demand, that we shall see in the near future low prices prevailing for cotton for any length of time.

Even if Lancashire does not herself use very large quantities of Indian cotton, yet two great advantages accrue to the English cotton industry from the extension of cotton cultivation in India, viz.:—

(1) Every additional bale of cotton raised in India liberates a bale of American cotton, and consequently lessens the demand and price for it. Seeing that this year's crop in India will probably amount to 6,000,000 bales, the boon to the cotton industry as a whole, as a result of a crop of these unprecedented dimensions, must

have been very great. Had the Indian crop been of normal size, the price of American cotton would undoubtedly have risen to record figures. As it is, the cotton manufacturing industry of the whole world has benefited.

(2) Lancashire's secondary advantage is, that by extending cotton cultivation in India by improved methods, especially by seed selection, the ryot becomes financially better off, the consequence being that he is able to spend more money on his clothing, of which about 90 per cent. is supplied by Lancashire.

# A NOTE ON THE IMPROVEMENT OF COTTON IN BRITISH INDIA.

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## I.—The Position of Indian Cotton up to 1890.

In Dr. J. Forbes Royle's book on the "Culture and Commerce of Cotton in India, etc.," published in 1851, we have an exhaustive account of the position of Indian cotton as it stood up to that year, and it is necessary to understand that the avowed object of all the early trials was to produce cotton which could compete on equal terms with that of America in, at least, the English markets. It was tacitly assumed that no indigenous kind could possibly answer the purpose, so that the experiments from the first were mainly directed to the introduction of superior exotic varieties.

The present section of this paper is compiled from Dr. Royle's book and some other sources with a view to make clear in what manner the problem of the improvement of Indian cotton was attacked before the establishment of the present Department of Agriculture in India.

Before the acute demand for cotton arose in the markets of the world India was looked upon as a great country which grew immense quantities of raw material, making it up into useful clothing for her own people. She was also famous from ancient times for exporting elegant fabrics to the most civilized nations. Now that such an increasing call for the raw material has been made, it has become usual to look upon the country as a vast cotton farm, whose business it should be to supply the raw material to Europe, and to take back in any quantities the manufactured goods that the makers choose to send. When we realize the consequences that would ensue in Europe in the event of an inadequate supply of cotton, we are not surprised to know that not only the manufacturers, but the general public even, are directly interested in the area of culture being extended. India, from its great extent and apparently illimitable powers of production, is looked to as the country capable of counterbalancing our irregularities of supply and cost. It is granted that it would be for the benefit of the Indian farmer to share more largely in the trade which the American planter nearly monopolizes. The reasons why the Indian farmer cannot compete on equal terms is ascribed either to mismanagement or to the absence of a regular demand and of remunerative prices. There is no doubt of the continuous demand for cotton in general, and, if India has anything to complain of in this respect, it must be either owing to the nature of the Indian cotton or to the state in which it is sent to market.

The first question which arises is, whether manufacturers in Europe require large quantities of such cotton as the people themselves use, or whether they require some other kinds which can be grown successfully in India?

To take first the nature and condition of Indian cotton, we find that with regard to its *quality*, it will be admitted that some of it at least must be quite fitted for the purposes of the cotton manufacturer, if we consider only the durability and substance of Indian calicoes, or the fineness in texture of the celebrated muslins. It is possible, however, that the cotton suitable for such purposes when spun by hand may be yet unfit for the rougher handling of machinery, more especially when we remember that the weavers of the Southern Provinces derive part of their success in manufacture from the softness of the climate, while in the Northern Provinces the weavers create the same atmosphere artificially by working in underground chambers, in which the air is maintained at its proper degree of moisture. It is probable, however, that the cotton in different tracts of such an extensive country may differ so much that what is produced in one part may be fit for European textile purposes, while that of another part may be quite unsuitable. The extent and regularity of the foreign demand for Indian cotton will therefore depend upon the proportion of that which is of the desired quality to that which is not required. It is also obvious that the best product may be sent in such a bad state to the market that its value will be greatly depreciated, and a prejudice against its regular employment will arise and persist. Indian cotton has always been held to possess the good qualities of colour, a high facility for taking some dyes better than American cotton, and for its thread-swelling in the process of bleaching, so that the cloth made from it becomes more substantial in appearance. To show the minute attention which was paid by the people of India to the cotton employed in calicoes and muslin, it is recorded, as long ago as 1789, that the general distinction in quality that the natives make is whether the thread made from any cotton swells or not in the bleaching. Most of the Indian cotton has one great defect, that is shortness of staple, which, although it can be twisted and spun between the fingers, may yet be blown away during the various processes of machine spinning; hence it has been found that the waste in using Surat cotton is 25 per cent., whilst from the American the loss is 12½ per cent.; and also the same machinery produces a larger quantity of yarn from the American than from the Surat cotton, and this is attributed to the more brittle character of the latter. An improvement of 10 to 25 per cent. in the quality of Indian cotton was considered necessary before its consumption would be materially increased. One reason for the small amount of waste in the American cotton was that most of it could be used for purposes of inferior spinning, while of the Surat a large portion cannot be worked into inferior articles. The shortness in the staple of the predominant classes of Indian cotton is undoubtedly the chief factor against its introduction into general use; but another chief cause is the dirty state in which it reaches the manufacturer, this condition being dependent on the careless manner in which it is collected and stored and to the fraudulent admixture made to it after purchase from the growers. All the evidence which has been collected points to the fact that the cultivator is not the only one at fault, and that, moreover, he is not encouraged to take any pains in improving the state of the product he brings to market.

*Experiments in the Improvement of Cotton.*

Long discussion established the fact that Indian cotton in its present state will never be used as a substitute for American, except when the latter is scarce and dear. The only method, therefore, open to India to secure a steady and profitable trade was to improve the condition and quality of the produce. Experiments were conducted under the auspices of the East India Company for a series of years, and the ultimate result was that no permanent improvement was effected in improving the cotton of India.

The following summary, taken from Dr. Royle's book, shows the measures adopted at different periods to improve the culture of cotton in India:—

1788.—The Court of Directors called the attention of the Indian Government to the cultivation of cotton in India, "with a view to affording every encouragement to its growth and improvement." 500,000 lb. weight of cotton were ordered to be sent. Reports were called for from the collectors of districts.

1789.—Screws for compressing cotton were at this time established, both by the Company and by individuals.

1790.—Cotton (422,207 lb.) received from India. Ahmood cotton seed directed to be sent to Bengal. Reports of culture at Bombay, Benares, and Dacca received, also from collectors of Bengal and Bihar. Dr. Anderson employed in distributing cotton seed from Mauritius and from Malta throughout the Peninsula of India.

1794.—A machine sent out for cleaning cotton from seed and other impurities.

1797.—A plantation, under Mr. M. Brown, established at Randatarra, in Malabar, chiefly for spices; but

Mauritius and Nankeen cottons were grown in 1801, and the produce sent to this country.

1799.—Nagpur cotton seed directed to be tried in the Circars, and a bounty offered to growers.

,, Dr. Roxburgh, Superintendent of the Botanical Garden, Calcutta, grew and described eight species of *Gossypium*.

1802-03.—Reports received on the cotton trade of Bombay and of the Gangetic Doab.

1809.—Cotton ordered from India. 30,000,000 lb. received in the following year.

1810.—Samples of Georgian and Grenada cottons sent out; also seeds of West Indian and of American cottons. Directions sent out for the culture of cotton, prepared by Mr. R. Hunt and by the African Society.

1811.—Bourbon seed procured and distributed to Collectors of Surat and Broach, with directions for cultivation.

1813.—Mr. B. Metcalfe, a cleaner of cotton from Georgia and New Orleans, sent to Tinnevelly with saw-gins.

,, Mr. Bruce directed to send cotton seed from Persia to India. Seed from Bourbon and Seychelles procured.

1814.—Two or three hundred bales of the best and cleanest Toomil cotton directed to be sent annually.

1816.—Collector at Caranja cultivates Bourbon cotton there.

,, Drawback allowed "of the whole internal and sea duties" on cotton exported to Great Britain.

,, Two improved gins sent to Bombay, one for cleaning black-seed, the other for green-seed cotton.

1817-19.—Mr. Assistant-Surgeon Gilder succeeds in cultivating Bourbon cotton at Kaira.

,, Cotton culture attempted in Circars by Commercial Residents, etc.

,, The Court suggest that, in addition to Caranja and Salsette, Malwan should be tried.

1818.—Satisfactory report from Malwan. Pernambuco seed asked for. Mr. Hughes successfully cultivates Bourbon cotton at Tinnevelly. Mr. Heath, having obtained instructions from Mr. Hughes, succeeds in Coimbatore. Memoir from Mr. Randall, Commercial Resident in Ceded Districts, proposing rewards for growing Brazil cotton in districts of Madras Presidency.

1818.—Four cotton farms of 400 acres directed to be established at Tinnevelly, Coimbatore, Masulipatam, and Vizagapatam.

1819.—Considerable success by Mr. Heath in Coimbatore. The cotton approved of in England, and 500 bales of 300 lb. each, sent to China, sold well there.

1823.—Barbados and Brazil cotton grown by Lady Hastings at Tittyghur, near Barrackpore.

1826.—Dr. Royle attempted culture of the Bourbon, Nurma, and common Indian cottons in the Botanic Garden, Saharunpore.

1828.—Attention again called to the subject of cotton culture by Lord Ellenborough, the President of the Indian Board, "in different and distant parts of India," and in an excellent paper by H. St. George Tucker, Esq., a member of the Court of Directors.

1829.—The Court direct attention to the growth of new and better species; send out machines for cleaning cotton; send out seeds of Upland Georgian and of New Orleans cotton; also Sea Island. Pernambuco, and Demerara cotton seed, with accounts of methods of cultivation; five of Whitney's saw-gins sent out to India, with twelve more made up in England, and metallic work for twelve sets to be made up in India.

,, A quantity of Surat cotton (500 bales) also ordered to be sent, of the best quality, and well cleaned.

,, Rewards to be offered, both to ryots and to wakarias, for clean picking and cleaning.

,, The Agricultural Society of India had an allowance of £1,000 a year, exclusive of rent, until 1833, to attempt the culture of cotton. Rs. 20,000 allowed for premiums for cotton and tobacco.

1829.—December 31.—Bombay Government report establishing a farm in Guzerat, under Mr. Finney; another in Dharwar, etc., under Dr. Lush; another in Salsette. Land offered for cultivation of cotton.

1830.—300 bales of Toomil cotton sent, and 25 bales from Broach Farm.

1831.—Partial success at Cotton Farm established at Akra, near Calcutta.

,, Buswant Sing, of Ahmednagar, encouraged to grow cotton.

1832.—The Court do not approve of bounty, but direct that land appropriated to the growth of cotton, sugar, etc., should not be subject to a higher assessment. 3,000 to 4,000 bales ordered to be sent, if procurable, at Rs. 115 per candy.

,, Disposal of cotton grown in the experimental farm of Guzerat for Rs. 152 to 156 per candy.

1833.—Reports from Collectors of Cuddapah, Guntoor, Arcot, Salem, and Coimbatore.

,, Farm subsidiary to that at Danda in Guzerat established, to be cultivated by ryots.

,, Farm established at Segee Hullee, in Bedere District, under Dr. Lush. White-seeded perennial (New Orleans?) succeeded; also the Pernambuco and Egyptian. Agency for the purchase of cotton from natives who had been instructed in picking it clean. Screws and packing sheds at Dharwar, Noulgond, and Gudduck. Natives had the option of paying their rents in kind or receiving a remunerative price. Foreign cotton seed also tried in Dharwar, Poona, and the Konkan.

1834.—Egyptian cotton seed and Egyptian cleaning machine applied for and supplied.

,, Machine for cleaning cotton in Brazil applied for.

,, Dr. Royle publishes an essay on the cultivation of cotton in India in his "Illustrations of Himalayan Botany," pp. 84-101.

1836.—Guzerat and Southern Mahratta Farms broken up.

,, Report of the proceedings of the East India

Company in regard to the production of cotton wool published.

1837.—Dr. Wight publishes an essay on the cotton culture of the Peninsula.

1839.—The Court of Directors propose undertaking a more complete experiment than any heretofore by procuring planters from America.

,, An excellent minute by the late Earl of Auckland on this subject, with reports from Madras and Bombay giving an account of the results of former experiments, as well as proposals for the present one.

,, Dr. Wight publishes figures, etc., of cotton plants in his "Illustrations of Indian Botany."

1840.—Mr. Elphinstone, Collector of Rutnagerry, succeeds in cultivating both Sea Island and Bourbon cotton.

,, Captain Bayles returned with ten planters from cotton States of North America, bringing with him seeds and saw-gins, ploughs and hoes, with model of a gin-house. A hand saw-gin was prepared at Liverpool. Dr. Royle drew up a report on the results hitherto obtained, and on the objects of the present experiment (*vide* "Productive Resources of India," pp. 312-355).

,, The Chairman, Deputy Chairman, and several of the Directors proceed to Liverpool to witness the working of the American saw-gins.

,, Three planters, assigned to Bombay, were sent to Broach, but shortly left India.

1841.—Three planters, sent to Madras, were first stationed at Tinnevelly, then at Coimbatore.

,, Four planters, sent to Calcutta, were stationed in the Doab and Bundelkhand.

,, Dr. Burns appointed to the charge of the experiments in Broach.

1842.—Dr. Wight succeeded Captain Hughes in the charge of the cotton experiments in Coimbatore, and still continues in charge.

,, An engineer sent to each of the three Presidencies to repair and put up machinery.

1842.—Mr. Shaw, the Collector, cultivates New Orleans cotton in Dharwar. Mr. Hadow, Assistant to the Collector, cultivates Bourbon cotton in Dharwar.

,, Mr. Mercer, having been burnt out of his farm in Bundelkhand, was transferred to Bombay, and stationed at Dharwar, where he was joined by Mr. Hawley, who afterwards went to Broach.

,, After two seasons the planters despair of success in the Doab.

,, Mr. Finnie explores the North-West Provinces for suitable sites.

1843.—Mr. Blount sent to Gorruckpore, but, not succeeding, went to Bombay.

,, Mr. Finnie establishes a model farm near Agra, but fails.

,, Mr. Price, an American planter, employed to introduce American cotton into Bengal, has had no success; is now endeavouring to improve the culture of Indian cotton.

,, Mr. Wroughton, Collector of Coimbatore, succeeds in growing New Orleans cotton.

1844.—Mr. Terry began cultivation in Rungpore, but soon left from ill-health.

1845.—Messrs. Simpson and Blount appointed to conduct experiments in Khandesh.

,, Cotton Committee appointed at Bombay to inquire into and report on causes of the decline of the cotton trade of India.

1847.—Mr. Landon appointed to carry on the experiments in Broach, where he is now established on his own account.

,, Return ordered by the House of Commons to be printed of the papers in possession of the East India Company, showing what measures have been taken since 1836 to introduce the growth of American cotton or to encourage the production of native cotton in India.

1848.—Mr. Blount, having returned from America, is engaged to take charge of the culture in Dharwar.

1848.—Report from the Select Committee of the House of Commons on the growth of cotton in India.

1849.—Mr. Simpson, having returned from America, is engaged to prosecute the experiments in Khandesh.

,, 200 cottage saw-gins, prepared under the superintendence of the Manchester Commercial Association and of Mr. Petrie, sent by the Court of Directors to the three Presidencies. Seeds and saws sent at various times during these experiments.

1850.—The Indian Government offers, through the Agricultural Society of India, a reward of Rs. 5,000 for an improved cotton-cleaning machine.

The underlying difficulty in the improvement of Indian cotton has been the indifference of the cultivators on the subject, and this frame of mind has been upheld by the lack of reward from the trade for their efforts and by the lack of direct contact with purchasers from the European markets.

The long series of failures which occurred was supposed by some to be due to the trials having been conducted by Government officers who had no personal interest in them. Others say that attention was not always paid to the peculiarities of soil and climate, and in the case of both failure and success no explanations were given of the causes which conduced to the results, and finally, although results were on record for a series of years, the same results were obtained and continued to be announced as new.

The following extract is from a letter from the Governor in Council at Bombay to the Court of Directors, dated May 30, 1812. After detailing the failures to grow cotton on Salsette Island, this letter goes on to say:—

"These failures are attributed to the same cause as those which have rendered many of the agricultural speculations in India abortive. The Hindoo labourer will never yield any adequate return for his wages when employed in agricultural concerns, even with the utmost vigilance of the farmer. The severe labour of working the soil, and every other duty incident to this calling, require a very strong interest to induce that attention to it which is absolutely necessary. This is entirely wanting in the day-labourer; nor is there any circumstance in his connection with his employer which gives him motives either of sympathy or dependence, which might excite in him sufficient attention to the work he is engaged in. It is different in manufactures, where the labourer employed is under the more immediate inspection of the master.

"The cultivators in small farms of the soil of Salsette are stated to evince such a deplorable apathy and indifference to their lot in life as to operate as a bar against prevailing on them to attempt, on their own account, a cultivation with which they are unacquainted. They have barely the means of providing for their families and paying their rents; they are incapable of enjoying any satisfaction which arises from new and successful pursuits; and it would be difficult to persuade them to hazard even the miserable provision they are now certain of, in the hope of obtaining a better one by any new or speculative undertaking."

All the experiments, however, did not prove to be absolute failures, and cotton of excellent quality was produced in several places. The Upland Georgian and New Orleans became so thoroughly established in the Southern Mahratta country of Bombay that they are now looked upon as indigenous; the Bourbon is seen as a garden plant over the whole of India, and as a field plant in some parts of Madras.

To conclude this brief account of the principles of improvement followed through many years under the old order of things, the sum of practical knowledge gained was that India is capable in many parts of producing cotton good enough to compete with the product of America, and that the enormous proportion of the indigenous article, on account of many well-defined defects, can never come into general use, and some of these defects have been due to the indifference of the cultivators to the state of the cotton produced by them, the want of encouragement to them from the trade to bestow more care in cultivation and marketing, and the systematic adulteration which is practised unchecked by the trade.

A scheme was formulated in England to raise a sum of £20,000,000 to be expended in India during five years in measures calculated to forward India as a cotton-producing country. The outbreak of the Mutiny put an end, however, to these negotiations.

Commenting on the effect of the American Civil War and the great Cotton Famine of 1862-66, Dr. Charles W. Dabney (*Bull. No.* 33, 1896, *U.S. Dept. Agric.*, "The Cotton Plant," p. 14) very truly observes: "Probably no equally great industry was ever more completely paralysed or had its future placed in greater jeopardy than cotton growing in the United States during the war of 1861-65. So great was the decrease in production which followed the effectual closing of the ports that only one bale of cotton was grown in 1864-65 for every fifteen bales raised in 1861-62. The chief menace to the future of cotton production lay in the efforts that were put forth by other cotton-growing countries at this time to produce those particular varieties which had for so long given the United States the monopoly of the European markets; and nothing could more completely demonstrate the remarkable adaptation of our Southern States to the growing of varieties which the experience of generations has proved to be the best for manufacturing purposes than the fact that it took them only thirteen years from the end of the war to regain the primary position which they held at its commencement."

In 1863 a Cotton Commissioner was appointed for Bombay, and the year following for Berar and the Central Provinces. Cotton farms were established under these Commissioners. The Bombay Cotton Frauds Act IX of 1863 became law, but it is generally believed it did more harm than good, and it was shortly after repealed. For the ten years ending 1859 the United Kingdom imported an average of 2,318,575 bales of cotton (each 400 lb.), and of that amount India supplied 405,291 bales. But in the ten years ending 1869, which included the troublous times of the American War, the United Kingdom imported an average of 2,736,661 bales, of which India supplied 1,282,172 bales—the record year being 1866, when India furnished 1,847,759 bales. Thirty years later (1899) the United Kingdom took 4,065,617 bales, of which India furnished only 77,297 bales, and in 1903 the Indian portion slightly improved, the United Kingdom having taken 203,550 bales of Indian cotton. The immediate response made by India during the cotton famine shows her capabilities, but, as in the United States, so in India, the demands of her own mills have now become the chief controlling factor in the amount available for export. The outcry in Europe was against the adulteration not the low-grade staple. The position of Indian cotton in the European markets was as a mixing fibre, or as a fibre to be used in upholstery. The success of Western intelligent agriculture over Eastern ignorance and greed was rapidly assured, and in time the Indian cotton fell so low that it was practically debarred from being imported into Liverpool. But the century closed with India, instead of exporting cotton goods, having become the largest single market for English manufactured cottons, its demands having been just under £20,000,000.

## II.—The Position of Indian Cotton from 1890 onwards.

Immediately on the establishment of the present Department of Agriculture in India it was realized that before further trials could be made in the improvement of the cotton crop, a very great deal of preliminary work had to be done. The indigenous cottons were first subjected to botanical classification, and as the work was commenced in the Bombay Presidency a start was naturally made with its cottons, which eventually proved to be more diverse than those found in the other large cotton tracts of India. When a fairly accurate knowledge of these cottons had been obtained a large number of varieties, found throughout the whole country, were collected by Mr. Mollison, then Inspector-General of Agriculture. These were grown in contiguous plots for three years, and after this period of study and observation an attempted classification of Indian cottons was published by the present writer. Another scheme of much the same character, and differing only in some minor details, was put forth by Sir George Watt in his admirable work on the "Wild and Cultivated Cottons of the World." Mr. F. Fletcher, some time Deputy Director of Agriculture, prepared a mass of material for a work of the same nature, but this has never seen the light.

In the Punjab, Mr. D. Milne, the Economic Botanist, has botanically surveyed the cottons of his Province. In the United Provinces, Mr. Martin Leake has been steadily working on the inheritance of characters in the cotton plant, and it is expected that valuable results will be the outcome of his patient work. In the Central Provinces Mr. Clouston has separated out all the types in his large cotton tract. Mr. Main has done the same in Bombay, and Mr. Sampson, by the separation of mixed varieties, in the Madras Presidency, has established at least one cotton of high merit.

So far, then, as the botany of Indian cotton is concerned, we may say now that we know definitely every form in India, and in most cases also the limits of each type.

The claims of adoption of several systems of scientific classification is still a matter of argument and discussion; but from a practical point of view it has been found more profitable in most of the Provinces to use the vernacular names known to the people, and this method is quite precise enough for ordinary purposes. As people were still possessed with the old idea that Indian cottons would be still inferior even if they were improved, a large number of foreign varieties of tree cottons were introduced, and sanguine persons actually risked loss by putting them out on a field scale at once.

Results of a few years' experiments proved plainly that these tree cottons possessed so many inherent defects that their profitable cultivation was impossible, results which probably coincide with the experience gained in every country in which they have been tried. It is certain that the Bourbon cotton gave hope of success in the Konkan and North Guzerat, and actually succeeded in establishing itself in the Salem and Coimbatore Districts of the Madras Presidency; but sooner or later, no matter what success was gained at first with it, the ultimate result was failure. At the present moment there is no serious cultivation of any tree cotton in India.

Trials were not, however, restricted to tree cottons, but many American and Egyptian annual varieties were also introduced and tested, especially in the Southern Mahratta country, where Upland Georgian and New Orleans cottons were so successfully introduced as to be looked upon now as indigenous; no higher class of American type has been found capable of acclimatization. The short season tracts without irrigation which preponderate in India and the black soil districts also have been found altogether unsuitable, and, so far as we can see at present, the successful cultivation of American and Egyptian annual cottons can only be conducted in the irrigation colonies of Sind and the Punjab, and perhaps in some parts of the United Provinces.

In the southern parts of the Madras Presidency an American type of cotton from Cambodia has been successfully introduced, and this also grows fairly well outside black soil areas where irrigation is practised.

In some parts of the Central Provinces another cotton of an Upland type has been introduced from Chota Nagpur, where it has been under cultivation for about a century. The area suitable for this cotton is restricted, and its quality is too low to enable it to compete with the product from America.

While the systematic study of the Indian cottons was in progress experiments were established with the purpose of finding out how much improvement could be effected in them by selection and hybridization. It was found impossible to cross Indian with American varieties, while all the Indian varieties could be easily hybridized. The summary of the results gained by these methods will be given separately for each Province.

*Bombay Presidency.*

In the Bombay Presidency there are four distinct cotton tracts:—

(1) Southern Mahratta country.
(2) and (3) North and South Guzerat.
(4) Deccan, with Khandesh.

In the Southern Mahratta country the two prevailing types of cotton are American, which had been acclimatized many years ago, and an Indian, which appears to be a degenerated type of Surat Broach cotton. As Dharwar American cotton showed but slight response to improvement by selection, it was decided to test the Cambodia, because that had given such excellent results in Madras. The success of Cambodia was more or less assured from the first, but as the cultivators have discovered that it thrives on a smaller rainfall than is required by the Dharwar American, the proportionate areas of each under cultivation is controlled by the amount of rain that falls at the sowing time. The prices realized during the present season prove that Cambodia cotton is intrinsically superior to Dharwar American.

On a day when the market rate of Dharwar American stood at Rs. 126 per Naga of 1,344 lb. of kapas, the corresponding rates for Cambodia cotton ranged from Rs. 196 to Rs. 166, the variation depending on the ginning percentage, which ranged from 37 and above to 32·5.

It has lately been ascertained that the Dharwar American cotton is composed of two varieties, the proportionate mixture of which appears to vary in different localities. It is expected that after all an improvement can be effected by selecting out the superior type.

The other cotton of the Southern Mahratta country is Kumpta, similar in the botanical characters to Broach, but producing an inferior cotton with a low ginning percentage. Experiments in selection and cross-fertilization in this Kumpta cotton have increased the ginning percentage from 25 to 29 on the Dharwar Farm. It yet remains to be seen whether the improvement will maintain itself over field areas. As Broach cotton outclasses Kumpta in colour and ginning percentage, some years ago it was considered that an immediate improvement could be effected by the direct introduction of Broach seed (from Navsari, which produces the best fibre).

The extension of this cotton in the Dharwar District will be limited, as the longer growing season of Broach would always be a strong factor against the possibility of its ever supplanting Kumpta to any degree. This was successful from the first, and last year the approximate area sown was about 4,000 to 5,000 acres. The season, on the whole, was unfavourable both to Broach and Kumpta cottons.

While the rate of Kumpta for the day was Rs. 129 per Naga of 1,344 lb. of kapas, that of Broach (Navsari seed) varied from Rs. 155 to Rs. 190, the ginning percentage ranging from 29·5 to 34.

In Broach cotton, which has been grown continuously at Dharwar for ten generations, the percentage has dropped from 34 to 29, which is 4 per cent. higher than average Kumpta even at its best; practically it will not be possible to grow Broach in this tract unless a considerable proportion of the seed is renewed at short intervals by direct importation, as, besides the loss in percentage, the Broach cotton degenerates also in colour and other qualities.

Many of the higher class of annual American cottons do not thrive in this tract. It is possible that one or some of these may be established in the future, but for the present we can only safely say that the successful introduction of Broach and Cambodia cottons have been made.

In Guzerat, with which is associated the peninsula of Kathiawar, the chief varieties belong to the *herbaceum* race, which produces the finest of the Indian cottons. These attain their highest quality in Navsari, extending northwards to above Surat; from Broach northwards a series of lower quality forms come in, and in the sandy alluvial soil (goradu) of North Guzerat a perennial variety is found scattered through other crops. In Kathiawar, since the advent of famine and years of uncertain rainfall, inferior types of *neglectum* have in many tracts completely ousted the *herbaceum*, which for many a year produced first-class cottons. In the tracts of deep and dense black soil in South Guzerat repeated experiments with numerous exotic varieties have proved their absolute unsuitability to this class of soil, and the

Department, therefore, has perforce to concentrate its energies on the problem of how to improve a product which, as it is, is admittedly amongst the most superior in India. By judicious crossing and selection a strain has been produced which is valued at 5 per cent. above the article ordinarily brought to market, and there is sufficient evidence at hand to warrant the hope that a still better result can be obtained. It is unfortunate that, as the improvement has been effected without any modification or alteration in the botanical characteristics of the local type of the plant, these better kinds cannot be distinguished in the fields, so that the trade have to rely on the testimony of the supervising officers of the Department that the cottons brought to market are really what they profess to be. In practice it seems that these cottons are accepted on their ginning percentage, which is slightly higher than in the case of the unselected types.

It will, therefore, be understood that in the Southern Guzerat tract the conditions are totally adverse to the introduction of any exotic variety whatever, and the only possible scope for improvement is in the raising of the standard, which is already sufficiently high. The new types, having been developed by crossing and selection of local forms, all belong to the same species. The only tangible distinctions which they present are slightly increased length of fibre and percentage of cotton to seed. Up to the limit of the black soil in the Broach District, northwards from Broach round Baroda and towards Cambay, where the soil is lighter than in the tract already dealt with, the cultivators find that the local varieties called Kanvi and Ghogari (the latter existing more as an admixture than as a pure crop on account of its high percentage) are more profitable to grow than the more valuable Broach. To the ordinary eye there is practically no difference in the appearance of the plants, but the environment has favoured the development of an agricultural race. In this tract the only improvement to be expected in the indigenous cottons is in a direction of an increased quantity and higher percentage.

The indigenous cotton of the Kaira District is a perennial variety called *rozi*, which lasts for four or more years. This is never grown except as a mixture with other crops. The soil of this district under normal conditions is suitable for the culture of exotics, and a fair measure of success has been obtained in the introduction of Cambodia under irrigation.

In years past there were strong hopes that Bourbon would succeed as a field crop under irrigation in this tract. The earlier results were very promising, but, as is usually the case with the exotic cottons in India, the series of adverse seasons destroyed the crop. Isolated plants continued to persist in the hedges especially, and it was a discovery of such that led Mr. Spence again to foster the hope that its cultivation would really be remunerative if conducted on the proper lines. His experiments also, after at first promising well, finally closed in the usual disaster.

The successive trials with many pure and crossed varieties of exotic, tree, and annual cottons on the Nadiad Farm over a series of years proved that, however well they flourished in normal years, they invariably succumbed to the vicissitudes of abnormal seasons.

In the succeeding District of Ahmedabad, of the three indigenous types called Lalio, Wagad, and Mathio, the latter in the Dhandhuka taluka bordering Kathiawar, the first two are *herbaceums* and the third is a *neglectum*. Lalio as an irrigated crop and Wagad as a dry crop, in the opinion of people most capable of judging, will always compete profitably with any exotic cotton introduced to this tract.

The statement on pp. 200-201, extracted from the Annual Report of the Surat Agricultural Station for 1912-13, gives the composition of the cotton crop as it naturally exists in the fields throughout Guzerat.

Although the greater proportion of the Guzerat cottons belong botanically to one species, they differ greatly amongst each other from an agricultural and commercial point of view. It is obvious that these well-known differences must be due to the physical constituents of the soils and climatic conditions. A number of soil samples were taken and submitted to Dr. Leather for physical and

STATEMENT OF ANALYSIS SHOWING THE COMPOSITION

| Name under which sample was received | Locality | Varadi | | Jari | | |
|---|---|---|---|---|---|---|
| | | G. Neglectum rosea | G. Neglectum rosea cutchica | G. Neglectum vera | G. Neglectum vera malvensis | G. Neglectum vera Kathiawarensis |
| *Ahmedabad District.* | | | | | | |
| Lalio | Dholka | — | — | — | — | — |
| Wagad | ,, | — | — | — | — | — |
| Lalio | Sanand | — | — | — | — | — |
| Wagad | ,, | — | — | — | — | — |
| Deshi | Viramgam | — | — | — | — | — |
| Lalio | Daskroi | — | — | — | — | — |
| *Kaira District.* | | | | | | |
| Rozi | Anand | — | — | — | — | — |
| ,, | Kapadvanj | — | — | — | — | — |
| Kanvi | Thasra | — | — | — | — | — |
| Rozi | ,, | — | — | — | — | — |
| Kanvi | Mehmadabad | — | — | — | — | — |
| Malvi | ,, | 33·4 | 25·0 | 8·3 | — | 13·9 |
| Kanvi | Matar | — | — | — | — | — |
| Jadiana | ,, | 38·5 | 3·8 | 15·4 | — | 38·5 |
| Deshi | Nadiad | — | — | — | — | — |
| Rozi | Borsad | — | — | — | — | — |
| American | ,, | — | — | — | — | — |
| *Panch Mahals.* | | | | | | |
| Deshi | Godhra | 4·0 | — | 36·0 | — | 60·0 |
| ,, | Halol | — | — | — | — | — |
| Kanvi | Kalol | — | — | — | — | — |
| Khandeshi | ,, | 44·4 | 26·0 | 7·4 | — | 11·1 |
| *Broach District.* | | | | | | |
| Deshi | Ankleshwar | — | — | — | — | — |
| ,, | Hansot | — | — | — | — | — |
| Ghogari | Rajpipla | — | — | — | — | — |
| ,, | Jambusar | — | — | — | — | — |
| ,, | Broach | — | — | — | — | — |
| Deshi | ,, | — | — | — | — | — |
| *Surat District.* | | | | | | |
| Deshi | Bardoli | — | — | — | — | — |
| Farm Seed | ,, | — | — | — | — | — |
| Deshi | Chikhly | — | — | — | — | — |
| ,, | Chorashi | — | — | — | — | — |
| ,, | Jalalpur | — | — | — | — | — |
| ,, | Mandvi | — | — | — | — | — |
| ,, | Olpad | — | — | — | — | — |
| ,, | Pardi | — | — | — | — | — |

OF THE COTTON CROP IN GUZERAT.

| Gossypium indicum | Gossypium hirsutum | | Gossypium herbaceum | | | | | Gossypium obtusifolium | Gossypium Barbadensis |
|---|---|---|---|---|---|---|---|---|---|
| Bani | American | Buri | Broach | Ghogari | Kanvi | Lalio | Wagad | Rozi | Bourbon |
| — | — | — | — | — | — | 89·3 | 10·7 | — | — |
| — | — | — | — | — | — | 10·0 | 90·0 | — | — |
| — | — | — | — | — | — | 97·3 | 2·7 | — | — |
| — | — | — | — | — | — | 13·6 | 77·3 | — | — |
| — | — | — | — | — | — | — | 100·0 | — | — |
| — | — | — | — | 58·3 | — | 41·7 | — | — | — |
| — | — | — | — | — | — | — | — | 100·0 | — |
| — | — | — | — | 14·2 | 60·8 | — | — | 25·0 | — |
| — | — | — | — | 58·0 | 41·9 | — | — | — | — |
| — | — | — | — | — | 3·7 | — | — | 96·3 | — |
| — | — | — | — | 45·2 | 54·8 | — | — | — | — |
| — | 19·4 | — | — | — | — | — | — | — | — |
| — | — | — | — | 47·8 | 52·2 | — | — | — | — |
| — | 3·8 | — | — | — | — | — | — | — | — |
| — | 4·5 | — | — | — | — | — | — | 95·5 | — |
| — | — | — | — | — | 16·7 | — | — | 83·3 | — |
| — | 100·0 | — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — | — | — |
| — | — | — | — | 51·4 | 48·6 | — | — | — | — |
| — | — | — | — | 56·8 | 43·2 | — | — | — | — |
| — | — | — | 11·1 | — | — | — | — | — | — |
| — | — | — | 63·6 | 36·3 | — | — | — | — | — |
| — | — | — | 93·1 | 6·9 | — | — | — | — | — |
| — | — | — | 89·7 | 10·3 | — | — | — | — | — |
| — | — | — | 7·9 | 92·1 | — | — | — | — | — |
| — | — | — | 20·7 | 79·3 | — | — | — | — | — |
| — | — | — | 52·4 | 47·6 | — | — | — | — | — |
| — | — | — | 100·0 | — | — | — | — | — | — |
| — | — | — | 100·0 | — | — | — | — | — | — |
| — | — | — | 100·0 | — | — | — | — | — | — |
| — | — | — | 91·7 | 8·3 | — | — | — | — | — |
| — | — | — | 100·0 | — | — | — | — | — | — |
| — | — | — | 100·0 | — | — | — | — | — | — |
| — | — | — | 97·5 | 2·5 | — | — | — | — | — |
| — | — | — | 100·0 | — | — | — | — | — | — |

chemical analysis, and at the same time samples of the cottons were also taken for valuation in the market. To take the soil samples first, the first three sets are all of goradu soils, which grow early ripening varieties of the *herbaceum* type called Kanvi and Lalio, the average rainfall of the first set being 41 in., of the second 35 in., of the third 29 in.

The clay and silt ranged from 29·1 to 32·5 per cent., sand from 67·5 to 76·2, and the percolation test gave 1 to 1·6 cm. per hour; taking the cotton of Navsari for the day as equal to 100, the cotton of this tract was valued at 87·5. The next sample was a besar soil growing Wagad, also a comparatively early variety of *herbaceum*. The rainfall in this tract averages 29 in., the proportion of clay and silt was 53, sand 47, the percolation test gave 0·7 cm. per hour; taking Navsari again at 100, the cotton from this tract is worth 89·28. The next set of samples were from the Broach District: average rainfall 41 in.; proportion of clay and silt 77·4, sand 22·6, percolation test 0·1 cm. per hour; value of the cotton equal to 92·8. The next two samples from the Surat District: rainfall average 39 in., proportion of clay and silt 74, sand 26, the percolation test 0·3 cm. per hour; the value of the cotton equal to 98·21. The last sample was from the Navsari tract: average rainfall 44 in.; proportion of clay and silt 66, sand 34, the percolation test 0·4 cm. per hour; the market value of the cotton equals 100. It will be seen from the above figures that the quality of the cotton is in direct proportion to the density of the soil.

In Kathiawar, the Native States of Morvi, Wankaner, Muli, Wadhwan, and Lakhatar grow pure Wagad and Kanvi cottons within their jurisdiction; the former is easily distinguished by its bolls not opening out when ripe; patches of Lalio in which the bolls open very widely are occasionally grown under irrigation. The remaining States in Kathiawar, in addition to the three forms mentioned above, grow also Mathio, a form of *neglectum*, which came into favour after the famine year of 1899-1900, on account of its greater drought-resisting nature. Mathio at present occupies a large area. Some of the

Native States are keen to improve the cotton crop. Advice is freely given, and seeds are being supplied of pure varieties of Lalio and *rosea*, the latter in place of Mathio, as the soil and other conditions are admirably fitted for this type of cotton.

In Khandesh and the closely adjoining parts of the Deccan we enter from the westward an enormous tract of country which produces the inferior class of cotton known as Bengals. The four principal types of cotton found in Khandesh consist of varieties of *neglectum*, two with yellow and two with white flowers. Upland Georgian is found everywhere as a slight admixture, and its presence here reminds us of the futile efforts which were once made to introduce it into this tract, its total acreage reaching 60,000 acres at one time.

In 1905 the four varieties of Khandesh cotton were separately grown, and the N.R. cotton, one of the constituents of this mixture, from 1909 has proved from field trials that it is the most hardy, best yielding, and the highest ginning variety of this tract. Mr. Main says that the results of the last two years confirm the opinion of experienced cultivators that N.R. cotton is more drought-resisting than the Khandesh mixture.

One cultivator reports having got a six-anna crop of N.R. and a three-anna crop of the Khandesh mixture on the same soil. The crop is relatively early maturing as compared with the yellow-flowered types; the bolls open well and mature uniformly. The summary of the results of four years shows that N.R. gives much the highest out-turn as compared with other types. It has also substantial advantage in ginning percentage, which secures for it a much better price in the Dhulia market, and the net profit per acre is strikingly superior in the case of N.R. The following valuations give the relative values of the components of the Khandesh mixture:—

| | Rs. | |
|---|---|---|
| Rosea N.R. ... ... ... | 280 | per candy of 784 lb. |
| R. cutchica N.R.C. ... ... | 272 | ,, ,, |
| Vera N.V. ... ... ... | 320 | ,, ,, |
| Malvensis N.V.M. ... ... | 277 | ,, ,, |
| Local Khandesh ... ... | 262 | ,, ,, |

The last is reported to be ordinary fully good Khandesh cotton. The seed farm at Jalgaon in East Khandesh has been started for the supply of pure-bred seed of N.R. variety to the cultivators, who are quite awake to its advantages.

*Sind.*

In 1911 Mr. Keatinge says in his note on "Improved and Exotic Cottons in the Bombay Presidency," that, of various kinds of Egyptian cottons grown in Sind, Mitaffifi is the only one that has given really good results. Owing to difficulties connected with the supply of irrigation water, the inferior agricultural methods of the cultivators and the long growing season of Egyptian compared with that of the local Sindhi cotton, and the disinclination of the trade to pay proper prices for the Egyptian cotton, its cultivation was abandoned, and since then Mr. Henderson has decided that there will be a far better chance for American Upland cottons, which can be grown on a fairly large scale in many parts of Sind. The local methods of cultivation are suitable for them, and as the growing season is shorter than that of Sindhi cotton they can be grown on the ordinary inundation canals and they can also be grown in Upper Sind, where at present practically no cotton is grown, and in many parts of Lower Sind, where the autumn mists are prejudicial to the later maturing of Sindhi cotton.

In the last published Departmental *Report* it is stated that, of the American cottons, "Triumph" stood first with regard to yield and suitability for growth in Sind under irrigation. Forty tons of seed of this had been imported and distributed amongst zaminders both in Upper Sind and the Jamrao tract. The leading merchants of the Bombay cotton trade have formed a syndicate to set up ginning and buying centres at Shikarpur and Mirpurkhas with the undertaking that the price paid for the produce will be based on the grading of samples sent to Liverpool.

From an experiment conducted with a view to seeing how far Sindhi cotton would respond to better methods of cultivation, it was found that an acre plot yielded 1,710 lb. of seed-cotton—a yield never before obtained except perhaps on very good virgin soils. The average is said to be about 800 lb.

The best cotton-growing tract in the whole of Sind for Sindhi cotton is said to be the Hala sub-division of the Hyderabad District; botanically the cotton is of the *neglectum* or Bengals type, and in growth it is much more robust than the best in other tracts.

### *Central Provinces and Berar.*

The cottons of this tract are in all respects similar to those of Khandesh. The admixture of Upland Georgian is most evident on the western side of the tract. Adjoining the Nizam's dominions, and being also the prevailing types throughout them, is the high-class cotton known in the trade as Hinganghat, existing not only as a kharif crop, but also as a rabi crop in some parts. Finally, in late years a plant known as Buri, a form of Upland Georgian long under cultivation in Chota Nagpur, is being grown to a considerable extent in parts where the local crop is suffering from wilt, as it is immune to that disease, which appears to be favoured by the continuous cropping of the land with cotton. The various forms of *neglectum*, which composed the crop, were isolated and tested separately some years ago by Mr. Clouston, the Deputy Director of Agriculture, and the following account is summarized from his reports:—

The experimental station at Akola now serves as a centre of a pure seed supply for a large number of seed farms, which again multiply the supply of selected Buri, *rosea*, and *malvensis*. The whole farm area is now being sown with pure strains of cotton raised from selected mother plants. To provide against possible deterioration plant to plant selection is annually undertaken; the selected strain of *rosea* now gives 40 per cent. of lint against 39 per cent. of the ordinary field crop. Mr. Clouston believes that, although it is subject to seasonal variations, a high ginning percentage is a hereditary character in cotton. Numerous crosses have been made between the different varieties, but no definite conclusions have been arrived at. Cambodia cotton and a variety of

Upland have been tested, but as they ripen a month later than indigenous varieties they produce a very small crop, and suffer from the want of moisture due to the cessation of the early rains in this tract.

When grown as a pure crop *rosea* gives at least 10 per cent. more lint than the ordinary field Jari, and its price is the same. This variety is known as Varhadi or Katil-vilayati.

*Rosea cutchica* is slightly inferior to *rosea* in the quality of its lint. It also yields heavily and is very hardy, the percentage of lint being, however, only 37 as compared with 40 of *rosea.*

*Malvensis* is the variety which is capable of greatest improvement in the quality of its staple. Different strains have been found to vary greatly in the quality of the lint, and it is therefore expected that in time it will be possible to evolve a better type than that under experiment at present. Its percentage of lint is about 30.

The strain of Bani or Hinganghat, which has been propagated at Akola, gives 29 per cent. against 26 per cent. for ordinary Bani, but its low yield and poor ginning percentage condemn it in the eyes of the cultivator.

The relative values per acre of certain cottons stood as follows after a trial over four years:—

| | Rs. |
|---|---|
| (1) Rosea ... ... ... ... ... | 70 |
| (2) Cutchica ... ... ... ... .. | 65 |
| (3) Ordinary Jari... ... ... ... ... | 58 |
| (4) Buri ... ... ... ... ... | 58 |
| (5) Malvensis ... ... ... ... ... | 57 |
| (6) Bani... ... ... ... ... ... | 44 |

This experience proves that at present market prices the two coarsest cottons, viz., *rosea* and *cutchica,* give most profit to the cultivator of the Central Provinces.

The table opposite gives the mixture found in the crops grown in the different parts of the Provinces.

Cotton grown continuously in the same field for a period of years has become a common practice. This method of cultivation is condemned by scientists, but after trials of some years no ill-effects occurred, and economically the practice has proved a sound one owing to the high price of cotton. The old idea that topping

| Local name | Place from which obtained (district) | Percentage of Cutchica | Rosea | Malvensis | Vera | Upland Georgian |
|---|---|---|---|---|---|---|
| Khateo cotton ... | Akola ... ... | 25 | 12 | 9 | 50 | 4 |
| Buri ... ... | Khamgaon (Akola) ... | 15 | 47 | 19 | 19 | 0 |
| Katilvilayati ... | Akot (Akola)... ... | 8 | 82 | 2 | 4 | 4 |
| Balapur Jari ... | Balapur (Akola) ... | 5 | 89 | 3 | 0 | 3 |
| Gaorani ... ... | ... ... ... | 10 | 40 | 10 | 40 | 0 |
| Jubbalpore ... ... | Jubbalpore ... ... | 0 | 0 | 29 | 71 | 0 |
| Panagarh ... ... | Jubbalpore ... ... | 0 | 0 | 18 | 82 | 0 |
| Patan ... ... | Jubbalpore ... ... | 0 | 0 | 12 | 88 | 0 |
| Deshi cotton ... | Harda (Hoshangabad) ... | 0 | 4 | 62 | 34 | 0 |
| Bhopali ... ... | Bhopal ... ... | 0 | 5 | 63 | 32 | 0 |
| Multai Jari ... ... | Betul ... ... | 5 | 70 | 15 | 5 | 5 |
| Katilvilayati ... | Chanda ... ... | 22 | 35 | 7 | 7 | 29 |
| Tinthidia ... ... | Seoni ... ... | 10 | 32 | 16 | 37 | 5 |
| Sausar ... ... | Chhindwara ... ... | 23 | 40 | 16 | 7 | 14 |
| Jari ... ... | Yeotmal ... ... | 18 | 70 | 2 | 10 | 0 |
| Katel ... ... | Yeotmal ... ... | 32 | 57 | 7 | 4 | 0 |
| Katilvilayati ... | Yeotmal ... ... | 22 | 57 | 9 | 12 | 0 |
| Hauri (Malkapur) ... | Buldana ... ... | 58 | 33 | 3 | 6 | 0 |
| Dharwar (Malkapur)... | Buldana ... ... | 17 | 80 | 0 | 3 | 0 |

plants increased branching and productiveness has been exploded in the case of cottons in these Provinces.

Manurial experiments have been carried out with a high degree of thoroughness, and the following facts appear to have been established.

Of cattle dung, saltpetre, and poudrette for cotton and juar in rotation, poudrette proved to be the most valuable. The results of the application of fertilizers was that the effect these had in increasing the yield of cotton had not been commensurate with the cost of the manure, although in every case there had been an increase of crop due to its use.

An application of cattle dung followed by top dressing of nitrate of soda and saltpetre has given distinctly promising results. By the adoption of dry-earth system of conserving the urine of cattle it is stated that a farmer can double his supply of manure.

### *Madras.*

The Presidency of Madras resembles that of Bombay in having a diverse series of species of cottons. In the northern parts we have an extension of the *herbaceums* from the Southern Mahratta Country. Mr. Mankad says that the ceded districts of Cudappah, Kurnool, and Anantpur are more or less divided into three distinct regions by the ranges of hills known as Erramalas and Nalamalas. West of the Erramalas are found *herbaceum* cottons known to the trade as Westerns. In the valley between the Erramalas and Nalamalas they are known under the trade name of Northerns. These are commercially superior to Westerns, the cotton having a slightly reddish tinge. On the east of Nalamalas is grown Yerrapatti, a variety of *Gossypium indicum* known under the trade name of Coconadas. Bellary, Anantpur, and a portion of Kurnool produce Westerns. Portions of Kurnool and Cudappah have Northerns. Portions of Cudappah and Guntur produce Yerrapatti. In the western and northern parts Yerrapatti is grown in lighter kinds of soils; the Coconada area grows mostly Yerrapatti in all kinds of soils. Northerns, on the whole, are considered superior and fetch the highest price.

In some places in the Koilpupla taluka District, Kurnool, and in the Bangampalli State one finds a naked-seeded *herbaceum*. The staple of this cotton is superior to that of Northerns, but its ginning percentage is only 23 to 25. The cultivators prefer this black seed for feeding their bullocks, as they consider that it contains more oil.

In the south of the Madras Presidency the cultivation of cotton comes in from Tanjore; the varieties grown are Uppam (*herbaceum*) down to Madura; from Madura to Tinnevelly, in addition to Uppam, is grown Karanganni, which is a variety of *Gossypium indicum*.

Imported Broach grows luxuriantly at Hagari with a high ginning percentage, but its long duration of growth is a drawback to its cultivation.

Selection experiments with the local cotton Jowari-Hatti (Westerns) are in progress. In 1912 the valuation of the selections made at Hagari Station proved that most were equal to the best class of Westerns. The naked black-seed cotton was considered by Messrs. Tata, Sons and Co. to be the best of the indigenous types in this tract, both in colour and length of fibre, but its ginning percentage is unfortunately low, being only 22·2.

On the Nandyal Agricultural Station selection experiments are in progress with Northerns. By recent valuation these are taken to be 10 to 20 per cent. better than Kumpta, and 30 to 40 per cent. better than Westerns.

Seed of selection No. 2 is being distributed. Cultivators do not hesitate to pay 10 per cent. over the local price for the selected seed.

On the Koilpatti Station experiments are in progress with types of Karanganni, which are uniform in ripening and give comparatively large returns and high ginning percentage. Strains from single plant selections are being grown on a field scale; the most promising which fulfil the desired conditions will be set aside for seed distribution.

The Uppam variety, which ripens earlier and is hardier than Karanganni, will probably always appeal to the cultivators who appreciate these points. Out of seventeen samples of selection Karanganni A type, six were valued at Rs. 25 higher than the price of fully good fair Tinnevelly; the rest of the samples were valued at Rs. 10 higher. Of eight samples of Karanganni C type, all were valued equal to average fully good fair Tinnevelly. Of eight samples of A/C of Karanganni type, all were valued equal to ordinary fully good fair Tinnevelly.

From Trichinopoly to Tinnevelly, Cambodia has become a regular garden crop, replacing tobacco, chillies, ragi, and other garden crops. The cultivation of this seems to have spread considerably in the Nandyal Valley along the Tungbhadra Canal, and in the Coimbatore District also. The produce has unfortunately suffered from admixture of inferior Madras cottons. This has been detected by the trade, and has rendered Madras cotton unsaleable as a high-class cotton.

The cultivation of Bourbon and Nadan varieties seems to be confined to the east of the Coimbatore District. The former is a survival of the crop introduced as early as 1817. The fields always consist of a mixture of the two varieties, and remain as they stand for three to four years. Soil containing a higher percentage of lime is preferred for Bourbon, and it is in this kind of soil that the proportion of Bourbon predominates. The reason for the mixed cropping is probably the fact that Bourbon in its early stages requires the shelter of the Nadan, which is fast-growing.

Neither gives any crop in the first year, and to get something in the way of return the cultivators grow with them bajri, tur, castor, etc.

Bourbon ripens from November to January and Nadan from February to April, so that the produce of each could be kept separate if necessary.

Tirrupur is a large commercial city, where this cotton is brought in every bazaar day, and bought by merchants at a price above that of local cotton. Some merchants have their petty agents stationed in different villages to bring this cotton, and it is these men who really do the sorting, *i.e.*, separating samples where Bourbon predominates from those in which Nadan predominates. The extension of pure Bourbon cotton in its own area as a dry crop does not seem practicable.

*Punjab.*

These Provinces are noteworthy in that, in addition to the predominance of various forms of *neglectum*, there are types of plants belonging to an annual form of *arboreum* known as *Gossypium sanguineum*, or Mooltan cotton. In the varieties of *neglectum* we have the usual variations in the leaf and colour of the flower, the yellow-flowered plants having a finer staple and a lower percentage of cotton to seed than those of the white-flowered types. In the *sanguineums* there are two types of flowers, a dark red and a pink.

In addition to these, there are varieties which have the botanical character of *indicum*, but the cotton of *neglectum*. With the exception of Mooltan cotton all these varieties extend into the North-West Frontier Province, which, in addition, also possesses what seems to be a hairy form of *obtusifolium*. Finally, there are series of American cottons, all introduced, and these fall into three varieties: Upland Georgian, New Orleans, Soft Peruvian.

The first, on account of its hardiness and immunity from the attacks of pests, is accepted as being obviously the type which should be introduced under canal cultivation. The second is less hardy in its nature and is more liable to the attack of insects, and its superiority to the first is so slight that it is not worth the extra risk. The Soft Peruvian variety (annual form) is one of the finest cottons ever grown in India. In spite of its higher price, its lower out-turn brings it on a financial level with Upland. It would be a remunerative crop to any farmer willing to undertake the extra trouble it requires.

Mr. Milne, the Economic Botanist, has discovered that the root-rot in cotton is caused by a nematode worm.

The aim of the Department is to improve the crop generally by improved methods of tillage and the selection and production of pure varieties, both indigenous and American.

With regard to the Colonies, the water requirement of the crop is an important factor. Water is scarce towards the end of the season, so a variety of cotton which ripens late is at a disadvantage.

The chief American cotton maintained for distribution is known as 4 F.

As irrigated tracts in the Punjab and Sind promise to be in future the chief sources from which cotton of the American type can be supplied, the experiments are engaging the interest and attention of the trade, and in this connection the following remarks of Messrs. Tata, Sons and Co. deserve careful consideration: "All the samples have one common characteristic of Dharwar Americans. As these cottons have been grown successfully for five years, the presumption is that the seeds have been thoroughly acclimatized, and the time has now arrived to make experiments on a large scale to see if it is a commercial success. If seeds are distributed to selected farmers and a good watch is kept on them to take care that they do not treat this cotton in the happy-go-lucky fashion they do the short-stapled indigenous cottons the result should be satisfactory, and the question of British-grown long-stapled cotton will, to a certain extent, be solved."

The Manager of the Empress Mills, Nagpur, has supplied the following results of the working of Lyallpur cotton, along with American, Bani, and Buri types.

The count spun was 24s warp, and in all cases number of turns per inch was the same.

| | Loss per cent. on cotton in blow-rooms | Tension of 24 s warp lb. |
|---|---|---|
| American F.G.M. Bowed ... | 7·75 ... | 57·44 |
| Panderkora Bani ... ... | 8·34 ... | 60·33 |
| Lyallpur ... ... ... | 10·08 ... | 52·20 |
| Buri (C.P.) ... ... ... | 10·37 ... | 46·10 |

The prices at the time of purchase were very nearly the same in all cases. On this basis, but including the blow-room loss, the purchase prices per lb. work out as below:—

| | Annas per lb. |
|---|---|
| American ... ... ... ... ... | 6·5 |
| Panderkora Bani ... ... ... ... | 6·53 |
| Lyallpur ... ... ... ... | 6·63 |
| Buri (C. P.) ... ... ... ... | 6·65 |

*United Provinces.*

The predominant cotton of this Province is composed of the usual mixture of *neglectum*, producing what is known in the trade as Bengals. Towards the eastern side of the Province a bushy cotton, the *intermedium* of Todaro, is grown in patches. It is found in the same way throughout the adjoining Provinces of Bihar and Orissa. The chief objection to its extensive cultivation is its long growing period. In addition to these, American Upland is also grown, but its chances of further extension are at present problematical. A few of the forms of *neglectum* have been separated and tried on the field scale, and, as in other parts of Bengals' tract, the white-flowered cotton is rapidly ousting the others on account of its hardiness, high out-turn, and high ginning percentage.

At present steps are being energetically taken to distribute new and improved varieties of *neglectum* cottons into the tracts most suitable to them. Mr. Leake is attempting to evolve a hybrid which will in time take the place of these, and the possibilities of American annual cottons, as they produce better staples, are being tested.

In Bihar and Orissa, Bengal, and Burma, the cotton crop is of such minor importance that the attentions of the Departments are concentrated on rice, jute, etc., which are their staples.

*Other Provinces.*

In Assam, the high yielding variety of the Garo Hills is being introduced into the other tracts.

In Burma, a beginning is to be made in the study of its cotton improvement.

Of the Native States, the Department of Agriculture, Baroda, is assisting in the work of the improvement of cotton in Guzerat and Kathiawar.

In the Hyderabad State, which provides 15 per cent. of the total crop in India, nothing appears to have been done.

In the States of Central India, Rajputana, and Mysore, much is being done in the shape of an extension of the work in adjoining British India tracts.

In conclusion, we have tried to make clear the fact that the object of the early experiments in the improvement of Indian cotton was directly to furnish a supply of a superior product to meet the needs of the English market. No thought was given to improve the crop for the use of the people of the country. The modern ideal is two-fold: firstly, to materially benefit the people of the country by improving the crop primarily grown for their own purposes; secondly, to introduce a better staple so as to avoid the necessity of importing foreign cottons and, in the event of a surplus, to compete with them in their own markets.

The percentages of the ordinary area under cotton in India in each Province, together with the estimated out-turn for the three years ending 1913-14, are given in Appendix A.

The usual percentage of loss that is found in the blow-room as regards the several descriptions of Indian cotton at present grown, kindly furnished by Messrs. Tata, Sons and Co., Bombay, appears in Appendix B.

## APPENDIX A.

| Provinces and States | Percentage of ordinary area under cotton | 1913-14 | | 1912-13 | | 1911-12 | |
|---|---|---|---|---|---|---|---|
| | | Area | Yield | Area | Yield | Area | Yield |
| | | Acres | Bales | Acres | Bales | Acres | Bales |
| Bombay, Baroda and Sind (*a*) ... ... | 32·3 | 7,432,000 | 1,705,000 | 7,122,000 | 1,643,000 | 6,132,000 | 819,000 |
| Central Provinces and Berar ... ... | 20·6 | 4,715,000 | 961,000 | 4,493,000 | 910,000 | 4,648,000 | 913,000 |
| Madras (*a*) ... ... ... ... | 9·1 | 2,593,000 | 513,000 | 2,414,000 | 471,000 | 2,878,000 | 335,000 |
| Punjab (*a*) ... ... ... ... | 6·9 | 2,053,000 | 594,000 | 1,575,000 | 373,000 | 1,582,000 | 241,000 |
| United Provinces (*a*) ... ... ... | 6·1 | 1,586,000 | 484,000 | 1,158,000 | 428,000 | 921,000 | 251,000 |
| Burma ... ... ... ... | 0·9 | 288,000 | 50,000 | 233,000 | 46,000 | 186,000 | 32,000 |
| Bihar and Orissa (*b*) ... ... ... | 0·3 | 86,000 | 19,000 | 92,000 | 19,000 | 88,000 | 19,000 |
| Bengal (*a*) ... ... ... ... | 0·3 | 51,000 | 13,000 | 51,000 | 21,000 | 63,000 | 25,000 |
| North-West Frontier ... ... ... | 0·2 | 59,000 | 14,000 | 56,000 | 13,000 | 56,000 | 12,000 |
| Assam ... ... ... ... | 0·2 | 33,000 | 12,000 | 35,000 | 10,000 | 36,000 | 11,000 |
| Ajmere-Merwara ... ... ... | 0·2 | 57,000 | 15,000 | 50,000 | 26,000 | 27,000 | 12,000 |
| Hyderabad ... ... ... ... | 15·2 | 3,653,000 | 400,000 | 2,888,000 | 300,000 | 3,234,000 | 300,000 |
| Central India ... ... ... | 5·4 | 1,426,000 | 273,000 | 1,314,000 | 206,000 | 1,400,000 | 228,000 |
| Rajputana ... ... ... ... | 1·9 | 470,000 | (*c*) 132,000 | 393,000 | 125,000 | 263,000 | 73,000 |
| Mysore ... ... ... ... | 0·4 | 93,000 | 16,000 | 154,000 | 19,000 | 101,000 | 17,000 |
| Total ... ... | | 24,595,000 | 5,201,000 | 22,028,000 | 4,610,000 | 21,615,000 | 3,288,000 |

N.B.—A bale contains 400 lb. of cleaned cotton.
(*a*) Including Native States within provincial boundaries.
(*b*) Excluding Native States, for which the yield is roughly estimated at 1,000 bales.
(*c*) For the Mewar and the Alwar States figures reported in the December forecast have been taken to make up the total, as final reports from those States have not been received.

## APPENDIX B.

STATEMENT OF PERCENTAGE OF LOSS FOUND IN THE BLOW-ROOM AS REGARDS THE SEVERAL DESCRIPTIONS OF INDIAN COTTON.

| Description | Superfine | Fine | Fully good | Good | Remarks |
|---|---|---|---|---|---|
| H.G. Bengal ... | 10 (Rajputana cotton only) | 13 | 17 | — | |
| M.G. Bengal ... | 8 | 10 | 13 | — | |
| M.G. Sind-Punjab | 9 | 11 | 14 | — | |
| M.G. Khandesh | — | 10 to 11 | 14 | 17 to 18 | |
| M.G. Dhamangam and Poolgam | 8 | 9 to 10 | — | — | If hand-ginned is mixed, loss will be 2 to 3 per cents more than fine clas. |
| M.G. Nagpur and Kaptee | 7 | 8 to 9 | — | — | Do. do. |
| M.G. Umravatee | 9 | 10 to 11 | — | — | Do. do. |
| M.G. Akola ... | 9 | 10 to 13 | — | — | Cotton in this district is generally watered before pressing, hence loss 2 per cent. higher |
| M.G. Khamgan | 10 | 11 to 12 | — | — | |
| M.G. Oomra ... | 9 | 10 to 11 | 14 | — | |
| M.G. Barsee ... | — | — | 13 to 14 | 17 to 18 | |
| M.G. Broach ... | 8 | 9 to 10 | 13 | — | If Khandesh kapas is mixed while ginning, loss per cent. will be more |
| M.G. Surat ... | 8 | 9 | 12 | — | Kim-Sayan loses more |
| M.G. Navsari ... | 7 | 8 to 9 | 11 | — | |
| M.G. Bhownagar (good stapled) | — | 13 | 17 | — | |
| H.G. Bhownagar | — | 15 | 19 to 20 | — | |
| M.G. Mathio ... | — | 11 | 14 to 15 | — | |
| M.G. Dhollera ... | — | 13 | 17 | — | |
| H.G. Dhollera ... | — | 15 | 19 to 20 | — | |
| Saw-ginned Dharwar | — | — | — | 10 to 12 | |
| M.G. Westerns ... | — | — | — | 13 to 14 | |
| H.G. Westerns ... | — | — | — | 17 to 18 | |
| M.G. Kumpta ... | — | — | — | 14 to 16 | More if mixed with hand-ginned |

# THE INTRODUCTION OF AMERICAN COTTON INTO SIND PROVINCE, INDIA.

By G. S. Henderson.

*Deputy Director of Agriculture, Sind.*

Cotton of a low class is cultivated in Sind, in Hyderabad, Thar and Parkar, and Nawabshah districts. The area of Sind is about equal to that of Egypt, and although the area under cotton has increased considerably in the last few years, the total annual cultivation even now is only about 4,000,000 to 5,000,000 acres. The present out-turn is about 150,000 bales per year besides what is used locally in the villages. Before the North Western Railway was opened in Sind the amount of cotton exported from that district was practically *nil*. Cotton cultivation is generally spreading northwards along the left bank of the Indus and eastwards on the Eastern Nara.

Cotton is a very profitable crop, and there is no reason why it should not be cultivated to a large extent in Upper Sind, on the non-rice lands. These latter are low-lying and have a large supply of flow water; rice lands are unsatisfactory as the excessive flooding necessary for the rice is not suitable for cotton.

The comparative costs and returns of cotton and other staple crops from the Government farms at Mirpurkhas and Sukkur are given in the statement opposite.

Sindhi cotton is short-stapled, coarse and strong, with a particularly good bright colour. In the market it ranks about the same as "Bengals." In the last few years the price has gone up considerably, and now runs to about Rs. 8.9 per maund of 81 lb., say 5½d. per lb. of lint, as compared with 7·30d. per lb. for Middling American (the price in Liverpool, May, 1914). Sindhi cotton gins up to 33 per cent. The best cotton comes from Shah-jo-bhit, near Hala.

STATEMENT SHOWING COMPARATIVE COSTS AND RETURNS OF CROPS, PER ACRE.

| 1912 | Sindhi Cotton | American Cotton | Egyptian Cotton | Jowari (Andropogon Sorghum) | Wheat |
|---|---|---|---|---|---|
| Grown on the Mirpurkhas Farm ... ... | Plot No. E. 11 | Plot No. E. 10 | Plot No. C. 3 | Plot No. D. 5 | Plot No. B. 9 |
| Yield in lb.... ... ... ... | 936 | 750 | 594 | 317, Kadbi 6,700 | 407, Chaff 889 |
| Value ... ... ... ... | Rs. 116.14.5 | Rs. 112.8 | Rs. 76.0.11 | Rs. 49.5.7 | Rs. 24.10.2 |
| Cost of cultivation ... ... ... | Rs. 28.6.4 | Rs. 35.2.3 | Rs. 31.0.2 | Rs. 27.9 | Rs. 20.10.1 |
| Profit ... ... ... ... | Rs. 88.8.1 | Rs. 77.5.9 | Rs. 45.0.9 | Rs. 21.12.7 | Rs. 4.0.1 |
| Grown on the Sukkur Farm ... ... | Plot No. A. 5 | Plot No. A. 4 | Plot No. A. 1 | Plot No. B. 5 | Plot No. D. 3 |
| Yield in lb. ... ... ... | 800 | 456 | 320 | Grain 620, Straw 150 bds. | 740 |
| Value ... ... ... ... | Rs. 90 | Rs. 66.5 | Rs. 52 | Rs. 32.2.6 | Rs. 44.2 |
| Cost of cultivation ... ... ... | Rs. 44 | Rs. 31.4 | Rs. 30.8.6 | Rs. 19.0.6 | Rs. 29.1.6 |
| Profit ... ... ... ... | Rs. 46 | Rs. 35.1 | Rs. 21.7.6 | Rs. 13.2 | Rs. 15.0.6 |

NOTES.—Costs do not include Government assessment.
Plots in Sukkur Farm are still not uniform owing to presence of "kalar" or salt.

Sindhi cotton cultivation is simple in the extreme. After irrigation seed is broadcasted on the surface and ploughed in. Thereafter the crop receives one or two hoeings and nothing further except irrigation from time to time till the crop is ready for picking.

The improvement of Sindhi cotton could have been attempted in several ways: —

(*a*) By producing a still coarser cotton with higher ginning out-turn. It is along these lines that some export firms wish to direct the work.

(*b*) By producing a finer and longer-stapled cotton suitable for spinning higher counts and weaving finer materials.

The problem was to find by experiment a cotton suitable to the country, but of a much higher grade. To grade up the indigenous cotton held out but little promise of success in comparison with the adoption of a superior variety from some other part of the world. Indian varieties of superior quality, such as Broach, were soon discarded as undesirable; Egyptian was then tried, and finally American.

When the Agricultural Department was first established in Sind about ten years ago, it was thought by the then Deputy Director of Agriculture, Mr. Fletcher, that Egyptian cotton would thrive in Sind. It did well on all the Government farms and it was decided to get a large area cultivated in the district. Four thousand acres were cultivated in one season by zemindars on the Jamrao Canal, the out-turn probably averaging 5 to 8 maunds per acre. Some difficulty was experienced in disposing of the crop, as Egyptian cotton is not used by any of the mills in Bombay, and the amount produced was not sufficient to put the article on a commercial footing. The Mitafifi variety was of good quality and was favourably reported on by brokers in Egypt. Auction sales were established by Government at Mirpurkhas to dispose of the produce, but the price obtained was very uneven. Up to Rs. 14 per maund of 81 lb. of seed-cotton was obtained on some occasions when the presence of buyers anxious to obtain a sample caused some competition. At other sales there was little or no demand. The ginning was another difficulty, the local gins being adapted for the local cotton and not giving good results with the Egyptian. Further, the local ginneries were not at all anxious to handle this cotton, and buyers often found themselves in difficulties.

The disadvantages connected with Egyptian cotton in Sind are: —

(*a*) It needs more careful cultivation than the Sindhi, and requires to be grown on ridges.

(*b*) It has a long growing period, and needs to be sown at the latest by the beginning of April, while the first picking is not generally ready till October. This entirely prevents its cultivation on the inundation canals. In fact, it is practically only on the Jamrao Canal, which is a perennial canal, that it can be grown at the present time.

The results of the efforts to introduce Egyptian cotton into Sind are, however, very interesting and instructive. It has been proved that, given proper conditions, it will thrive well in the district, which is one of the few places outside Egypt where this class of cotton has been successful. In the future, when the country fills up and more intensive cultivation is adopted, it is possible that Egyptian cotton may be cultivated in Sind.

Experiments with American cotton were begun several years ago. It was found to be promising, and among its advantages were: —

(*a*) Its quick growing period; it can be sown in June, and the first picking is available in the end of September. This is most important for Sind, as it enables it to be cultivated on the common inundation canals.

(*b*) It is a good yielder, and on average land will produce as much as Sindhi cotton per acre.

(*c*) It seems to be hardy, and can be cultivated in the same manner as Sindhi cotton.

(*d*) The marketing of the crop is much easier than in the case of Egyptian cotton.

The writer paid a visit to the chief American cotton-growing centres, and selected the variety called "Triumph" as being most suitable for cultivation in Sind. It is a big-bolled variety, an early and good yielder, and is adapted for growth under irrigation.

As a result of repeated trials on the Government farms at Mirpurkhas and Sukkur, and on sub-stations at Jacobabad, Shikarpur, Nawabshah, and Tando Mahomedkhan, it was decided to commence its cultivation in the district on a large scale. Forty tons of Triumph seed were obtained from America, 10 tons being distributed, in the beginning of 1913, in Sukkur and Upper Sind Frontier, and 30 tons in the Jamrao area. The seed was distributed in good time, and officers of the Department toured from village to village, interviewing all growers personally.

A considerable amount of American cotton is used in Bombay mills, so it is much to the owner's advantage if they can buy a high grade of American cotton in India. A syndicate, consisting chiefly of Bombay millowners, was formed to buy, gin, bale, and dispose of the produce of the Triumph seed distributed by the Agricultural Department. The syndicate erected cotton gins at Mirpurkhas and Shikarpur, and the former is now in operation.

It was not possible to fix a price per maund of kapas to be paid to the growers, as the amount of expenses for ginning, baling, and freight could not be calculated in the first season. The syndicate, however, arranged to pay on delivery of the seed-cotton at the ginnery one-half of the current price of Middling American cotton, as quoted in the *Times of India*, and the remainder of the price being paid to the growers after the cotton and cotton seed were sold.

It is unfortunate that the season and inundation have been quite unsuitable for cotton in Upper Sind, and only 300 or 400 maunds of seed-cotton have been obtained. However, where the cotton has had a fair chance and conditions have been observed it has been successful.

In Lower Sind most of the growers are satisfied, and the cotton came in satisfactorily to the gin. One large owner has indented for 300 maunds, *i.e.*, sufficient to sow 1,200 acres, for the next season.

The crop consisted of 511 bales. This was sold in Liverpool at an average price of 1d. per lb. below that of Middling American. After deducting expenses the return to the growers was about Rs. 9 per maund of seed-cotton, Sindhi seed-cotton being at the time at Rs. 6 per maund.

Sufficient seed to sow 6,000 acres has been distributed in the districts. With the increased quantity of the produce and better ginning it is expected that the cotton will grade as Middling American.

A seed farm of 200 acres has been acquired by the Department to prevent deterioration and mixing of the seed. The farm cotton will be under careful inspection, and the produce will be specially ginned on the farm.

It is too soon to say if the cotton is established on a practical basis in Lower Sind or not. But it is undoubtedly a fact that a high-grade American cotton can be grown in Sind under ordinary Sindhi cultivation and will give a good out-turn. Economic conditions may, however, prevent its permanent establishment.

# PROBLEMS IN CONNECTION WITH COTTON CULTIVATION IN EGYPT.

By Gerald C. Dudgeon, F.E.S.

*Consulting Agriculturist to the Ministry of Agriculture, Egypt; Vice-President of the International Association for Tropical Agriculture.*

The unique position which has been attained by Egypt with respect to the cultivation of cotton is chiefly due to the remarkable equality of climatic conditions which prevails and the control which is capable of being exercised upon the water supply of the land.

The area under cotton cultivation has increased fairly steadily during the past ten years, exhibiting the following proportions with respect to the cultivable lands of the country:—

| Year | Per cent. |
|---|---|
| 1904 | 26·7 |
| 1905 | 28·9 |
| 1906 | 28·0 |
| 1907 | 29·6 |
| 1908 | 30·8 |
| 1909 | 29·7 |
| 1910 | 30·7 |
| 1911 | 32·5 |
| 1912 | 32·5 |
| 1913 | 32·6 |

If Lower Egypt (including Gizeh) alone be taken into consideration, cotton will be found to represent 42·7 per cent. of the area in that part for 1913. Further expansion is checked for some time, owing to the fact that the drainage on certain lands is inefficient. Large tracts exist approximating some of the most productive cotton areas, on which it has been rendered necessary to introduce frequently a land-washing crop, such as rice, in order to get rid of the salt which rises to the surface in the subsoil water with the advent of the flood. Without the introduction of such cultivation, the surface soil in these areas speedily becomes impregnated with salt, to the great injury of all subsequent crops. Rice is thus employed as a recurring reclamation crop, and must continue to be so used until the system of drainage is completely revised to obtain for these areas the same advantages as those which are found elsewhere.

There are, in addition to the lands referred to, others in which no drainage exists at all, and which are permanently without reclamation or crops.

The greatest obstacle attached to the drainage of such lands as those mentioned is that the proprietors of certain portions are unwilling to combine with the remainder for their mutual benefit; those having lands approximating the main drains usually objecting to the drains of their more remotely placed neighbours emptying into their own drains or even passing through their lands. This state of affairs has been brought about by the incompleteness of the methods employed in the first instance for the establishment of a canal and drainage system. The fact that it is insufficient in any system of drainage to lay down the main channels without at the same time putting in the branch and subsidiary ones seems to have been overlooked, with the result of a deadlock.

A remedy which suggests itself is that the Government should annually select blocks of convenient size, and in these construct all the necessary feeder drains, levying a tax upon the proprietors of the lands drained to cover the whole cost of the upkeep. By this means such a vast benefit would accrue to the present possessors of the land to be drained that it is certain that the majority would willingly agree to the adoption of such a scheme. An increase of the cotton and wheat-growing area and the decrease of that under rice would almost immediately ensue, and the economy in water due to this change would at once be apparent.

It has been assumed that when the co-operative movement has more fully developed the societies themselves would undertake the work of improving and rendering fit for cotton cultivation the lands of their less fortunately placed members by giving them access to the main drains through the lands of their more fortunate neighbours, but, judging from the spirit shown by the people at this moment, this seems an unlikely occurrence. Indeed, it is often found at the present time that the small proprietor is the victim of his neighbour who has large possessions, and who frequently uses the small man's land as a convenient discharge area for his own drainage.

The proper expansion of the cotton-growing area in Egypt is largely controlled by the conditions just mentioned, but no improvement of the lands referred to can be carried out except it be undertaken on a large scale, as all portions of the area served by the same canal section and discharging into the same main drain must necessarily be interdependent.

The reclamation of lands in the north of the Delta will produce new areas available for cotton cultivation after some years, but in the present condition of the Nile most of the reclamation projects must be temporarily abandoned. It should be mentioned in this connection that it cannot be anticipated that the cotton yield from these lands will attain the same average per feddan as that of the more favourably placed localities.

Meanwhile, if an increase of area under cotton should occur in the near future, it must be interpreted as corresponding to a diminution of the cultivation of food grain, chiefly wheat. Such a diminution is of some importance to the country. Although wheat is not such a remunerative crop as cotton at the present price of the latter, the further increased frequency of cotton in the rotation would in some instances produce a diminished yield of lint, and it is more advantageous to the soil to retain it in a naturally fertile condition than to be compelled to resort to the application of artificial manures to procure a normal result.

It is not generally realized to what extent Egypt is self-supporting in the matter of food supply. The accompanying table which I have drawn up (p. 226) gives, I think, a clear indication of the economic situation, besides being an interesting demonstration of the richness of the country. For the purpose of making a comparative estimate of the country's consumption of food grain, the crops of each year (the earliest harvested of which are beans, wheat, and barley) must be assumed to become available for consumption from June 1. All the calculations, therefore, with regard to imports and exports in the table are made to apply to the same period instead of that of the usual financial year.

I have previously pointed out that 32 per cent. of the cultivable area is given up to the production of cotton, but it will be seen from the table that 95 per cent. of the grain used by the population for food is grown in the country.

It will also be seen that the consumption approximates three and three-quarter million tons each year, but is slightly decreasing, in spite of the population being estimated to increase at the rate of 1·51 per cent. annually. The decrease in production may be accounted for to some extent by the increase in the area under cotton, but the decrease in consumption is more difficult to explain. It has been stated that in each year there is increased consumption of meat, but this is not borne out by the figures obtained for the numbers of animals slaughtered for food; there is, in fact, a slight decrease in the latter from 1910, in which year the maximum number were slaughtered.

It would be inadvisable to further diminish the area under food grain in order to plant cotton. Although it is improbable that the gradual increase of the cotton area at the expense of that of grain has caused any general depreciation in the weight of the cotton yield per feddan, the limit of safety has probably now been reached in many places.

The system of rotation of crops has undergone a considerable change in the country since the price of cotton has increased. Formerly it was a common practice to plant cotton once in a period of three years; but more recently a two-yearly rotation has been adopted, and is now very generally employed. In some instances this increased frequency of cotton upon the same piece of land has resulted in a diminution of yield, but in others there has been no such an effect. Again, in a few instances it has been found possible even to plant cotton for several years in succession without the employment of extraordinary methods of resuscitating the soil and

PRODUCTION AND CONSUMPTION OF FOOD GRAINS IN EGYPT.

| Crops | 1909 | | 1910 | | 1911 | | 1912 | | 1913 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1,000 tons | £E. 1,000 | 1,000 tons | £E. 1,000 | 1,000 tons | £E. 1,000 | 1,000 tons | £E. 1,000 | 1,000 tons | £E. 1,000 |
| Millet ... ... ... | 303 | 2,246 | 280 | 1,487 | 226 | 1,291 | 231 | 1,402 | 191 | 1,451 |
| Maize ... ... ... | 1,426 | 10,572 | 1,491 | 7,923 | 1,478 | 8,445 | 1,532 | 9,301 | 1,449 | 11,085 |
| Wheat ... ... ... | 927 | 7,917 | 888 | 6,494 | 1,032 | 8,036 | 841 | 6,868 | 1,046 | 9,909 |
| Barley ... ... ... | 280 | 1,773 | 249 | 1,573 | 255 | 1,592 | 247 | 1,659 | 249 | 2,085 |
| Rice ... ... ... | 134 | 1,545 | 138 | 1,377 | 113 | 1,089 | 99 | 1,125 | 112 | 1,291 |
| Beans ... ... ... | 527 | 4,079 | 522 | 3,088 | 504 | 3,008 | 482 | 3,016 | 445 | 3,974 |
| Lentils ... ... ... | — | — | — | — | — | — | 44 | 364 | 42 | 406 |
| Total ... ... | 3,597 | 28,132 | 3,568 | 21,942 | 3,608 | 23,461 | 3,476 | 23,735 | 3,534 | 30,201 |
| Deduct Exports ... ... | 37 | 311 | 47 | 385 | 46 | 395 | 29 | 331 | — | — |
| | 3,560 | 27,821 | 3,521 | 21,557 | 3,562 | 23,066 | 3,447 | 23,404 | — | — |
| Add Imports ... ... | 215 | 2,046 | 203 | 1,851 | 195 | 1,928 | 240 | 2,544 | — | — |
| Consumption ... ... | 3,775 | 29,867 | 3,724 | 23,408 | 3,757 | 24,994 | 3,687 | 25,948 | — | — |
| Population ... .. | 11,636,000 | | 11,811,000 | | 11,989,000 | | 12,170,000 | | 12,354,000 | |
| Consumption per head ... | 0·324 tons | | 0·315 tons | | 0·313 tons | | 0·303 tons | | — | |

*N.B.—The increase in population is taken at an average of* 1·51 *per cent. per annum since the last census.*

without deterioration of the crop. The chief reason for the substitution of a two years' for a three years' rotation is that, in accordance with the rise in the price of cotton, the demand for land has risen, and the land itself has changed hands at an enhanced price. The new purchasers, finding that the monetary return from a cotton crop so far exceeded that from any of the other crops which they could grow, planted cotton as frequently as possible. Tenants, who previously used to obtain leases of land for three years upon the old rotation system, are now offered two-year leases. This method is now general, except upon a few very large estates in the country, but the effect upon the yield caused by the alteration in the rotation has scarcely been felt. The soil, which for the most part consists of Nile silt, is impoverished to a very small degree by the crop growing upon it. It is renovated to some extent also each year by the frequent application of Nile water carrying fertilizing matter in suspension even when not in flood.

In this connection it has been frequently assumed that the thick flood water alone had a beneficial effect upon the soil as a fertilizer, but from analytical tests which have been made, it has been ascertained that there is just as much plant-feeding matter in the ordinary Nile water as is found in the "red water" of the flood. A deterioration of the quantity of cotton yielded per feddan, as well as of its quality, is predicted by some, and is attributed to the action of the Assuan reservoir and the canal system in holding up the silt; but it should be remembered that that which is deposited upon the canal bottoms is the heavier material, mainly disintegrated rock, and in any case any value it may possess is not lost, as it is applied to the lands to a large extent when the cleaning of canals is in progress. Any temporary deterioration in the quality of cotton, which is a defect chiefly noticeable in the second and third pickings, is mainly due to the attacks of the Earias boll worm or to shortage of water. The more recently introduced pink boll worm (*Gelechia gossypiella*) is actually more destructive to seed than to lint, and is less likely to seriously affect the quality or yield from the cotton areas.

The effect of the low Nile in 1913 will probably make itself felt in some parts of Northern Egypt in 1914 and 1915. Owing to the deficient water supply summer rice cultivation is rendered impossible in the depressed and badly drained parts of the Delta, where such a crop is an almost imperative necessity to render the land sufficiently sweet to grow cotton. The result may cause a reduction of from one-half to one kantar in the cotton crop in 1915 from these localities, unless the situation is improved by the advent of a good flood in 1914 to enable the sowing of a flood crop of rice.

It has been anticipated that the suppression of rice growing in 1914 will result in an increase of the area under cotton; but it seems scarcely likely that those lands which in the ordinary course require a land-washing crop this year would be in a sufficiently good condition to produce a cotton crop.

The stability of the economic position in Egypt and of Egyptian investments is often said to be depreciated by the fact that the country is given up to the cultivation of cotton as its sole exported crop, yet it is surely a sound procedure to cultivate to the utmost cotton which can command a price above that of the product grown in almost any other country, at least until such a time as a similarly good quality can be brought into serious competition with it. That there should be any increasing deterioration in the quality of the cotton produced in the future is highly improbable. In a century of cotton growing, during which no organized general effort has been made to preserve the quality, the latter has preserved itself in a marked degree; much less, therefore, at the present time, when every opportunity is being taken to improve the fibre and the yield by the best known methods, should there be fear of increased or permanent deterioration.

No other crop which has been tried in Egypt gives quite such a highly remunerative yield as cotton at present; but should the unexpected occur, and, through any unforeseen cause, should there be a great diminution of yield per feddan or serious fall in price, a moderate substitute might be found in wheat, rice, maize, sugar, or oil seeds, all of which could be remuneratively grown for export.

The productive power of the land is superior to that of any other tract of equal dimensions at present under cultivation, and there are fewer disturbing factors than in other countries, so that Egypt without cotton would occupy no mean position as a competitor in the markets of the world.

So far I have chiefly referred to the question of the extension of the cotton area in relation to the diminution of the output of lint per feddan and the effect upon the food crops.

Without entering into a detailed discussion of the many problems directly attached to cotton cultivation in this country, the conditions of which render such cultivation widely different from that found elsewhere, it may be of interest to refer to two important factors which exercise an influence upon the quality. The first of these is the diversity of varieties of cotton cultivated at the present time in the comparatively small and congested area, and the second, the occurrence of insect pests and maladies during the plants' growth.

In the search for new kinds of cotton which shall possess to a marked degree any of the desirable features from the supposed point of view of the spinner, many people in Egypt have, from time to time, preserved the seed produced by hybrids or natural varieties which have appeared in their fields. The progeny of by far the larger number of these have been disappointing, and have shown no constancy in the characters aimed at, but occasionally the contrary has been the case, and the foundation of a new strain has been established. In this manner such cottons as Ashmouni, Mitafifi, Abassi, Jannovitch, Nubari, Sakellaridis, Assili, Voltos, and many other well-known kinds have been produced, all of which have been isolated in the first instance, only to be brought together again as the demand for them has increased and their planted area has become extended; so it happens, at the present time, that most of the varieties named are being grown in close proximity to one another, and frequently even in adjoining fields. The fixed characters of such varieties slowly break down by hybridization, the varieties themselves becoming more and more impure each year. Even a greater assistance to their degradation is the difficulty of keeping the seed unmixed in the operation of ginning. The mixture of seed in the ginneries, as well as the hybridization of plants in the field, was of a small degree of importance ten years ago, when the number of varieties were fewer and the areas under cotton were rather less congested; but the subject has now assumed a very prominent position for consideration in connection with the preservation of the quality of cotton, and the formation of the Department of Agriculture in Egypt occurred just in time to take this question up in a serious manner. The distribution of cotton seed by the Government and the propagation of approved pure strains of cotton, intended to be in continuous supply to the country, were the means adopted to counteract the deterioration which threatened to become widespread. The success which the first project has attained can be seen from the following figures of distribution: 1910-11, 8,600 bushels; 1911-12, 235,000 bushels; and 1912-13, 460,000 bushels. The distribution for 1913-14 approximates 700,000 bushels.

With regard to breeding pure cottons, the Ministry of Agriculture possesses several types which have been evolved by Mendelian methods in experimental farms by the late botanist to the Ministry, Mr. L. Balls, the seed from some of which are now being propagated with a view to distribution year by year upon an increasing scale. Uniformity of staple is certainly prejudiced so long as cultivators plant different varieties upon proximate areas, and ginneries are constructed more with a view to the mechanical separation of lint and seed than for the prevention of admixture of the varieties of the latter, but such adverse effects should be reduced to a minimum, and possibly even overcome altogether by the methods adopted at present by the Government to combat the evils.

Inferiority of quality caused by the attacks of insect pests cannot be regarded as a permanent effect, although in a country such as Egypt, where the cultivated areas are so isolated from those of other countries that counterbalancing influences can only be artificially introduced, and climatic conditions are almost invariable, insect pests thrive to the greatest extent after once becoming established, and, in some cases by reason by their recurring attacks, have become quasi-permanent. In practice, therefore, we find that such a pest as the Earias boll worm, for instance, exercises a continuous influence on the quality of the later pickings of cotton, the severity of which varies each year, chiefly in accordance with the time of maturity of the crop. This same pest contributes more than any other to the loss in yield as well as in quality in the manner mentioned, and it frequently happens that in a late maturing year the estimation of the cotton crop is rendered difficult at the time of ripening by the occurrence of a few days of cool or misty weather which favours the activity of the pest.

Efforts to suppress the virulence of the Earias boll worm pest have been severely handicapped by the difficulties in the way of carrying out the administrative measures recommended. In order that the insects may be reduced to their minimum in quantity during the winter, it becomes necessary that all old bolls remaining on the dead cotton sticks should be destroyed by fire, as it is within these bolls that the Earias boll worm, as well as the Gelechia seed worm, undergo their period of hibernation to a great extent. The destruction of the food plants of the species, such as volunteer cotton, and the several species of *Hibiscus* growing in the country, in conjunction with the dried bolls themselves, is a necessity. The removal of the dried bolls from the dead cotton plants is a rather laborious process, and, as the dried plants themselves are the main source of fuel used in the country, the insistence on the destruction of these altogether is scarcely to be considered. Experiments have recently been made with the conversion of the dried cotton plants into charcoal, and this has met with some measure of success. Our experiments show that, although the weight of the fuel is decreased in the operation to about 25 per cent., the calorific value of the charcoal is about two and a half times that of the wood, so that the loss for culinary purposes is little more than a third in heating power. The cost of conversion is of some consideration, but should be amply repaid by the diminution of boll worms in the following years' cotton.

A modification of the existing law in connection with the measures for the prevention of boll worm propagation is under consideration by the Government, certain important alterations having been made with a view to meeting the situation caused by the advent of a new pest, the pink boll worm (*Gelechia gossypiella*). If the proposals made be adopted and the law be vigorously carried out, great benefit will accrue to the agriculturist in the country, and the quality of the cotton, especially with respect to the later pickings, will be much improved.

The damage to the cotton crop effected by the Earias boll worm is far in excess of that of any other Egyptian cotton pest. An idea can be got of the probable rate of increase of this pest between January and September in any year by an examination of the following figures:—

2 (1 pair) produce 200 eggs, of which 20 insects mature.

20 (10 pairs) produce 200 eggs per pair = 2,000, of which 1,000 mature.

1,000 (500 pairs) produce 200 eggs per pair = 100,000, of which 50,000 mature.

50,000 (25,000 pairs) produce 200 eggs per pair = 5,000,000, of which 2,500,000 mature.

Hence from the one pair, allowing that only 10 per cent. survive in the first generation due to scarcity of food, and that 50 per cent. do so in each of the subsequent three generations, two and a half million boll worms will be produced to destroy the crop in September. This is an indication of what immense good would be effected by a vigorous campaign against this pest at the period when the vitality of the species is at a low ebb and the food supply can be most easily controlled.

In this paper a selection has been made of three important problems relative to cotton cultivation in Egypt, the first having reference to the possibilities of extension of the planted area and the effect upon the remaining land, and the other two to the influences opposing the maintenance of the standard quality of the product. All three are of great importance to the country, and continuously occupy the attention of the Egyptian Government, as well as of his Britannic Majesty's Agent and Consul-General, at whose instigation so many important reforms have been introduced into the country.

## COTTON CULTIVATION IN UGANDA.

By Samuel Simpson, B.Sc.

*Director of Agriculture, Uganda.*

The Uganda Protectorate produces more cotton than any other country in Africa, with the exception of Egypt, and the cotton industry is the most important one in the Protectorate. The following statistics show that the industry is making steady progress:—

Lint Exported to March 31.

| Year | | Quantity. Cwt. | | Value. £ |
|---|---|---|---|---|
| 1904–05 | ... | 180 | ... | 236 |
| 1905–06 | ... | 860 | ... | 1,087 |
| 1906–07 | ... | 3.500 | ... | 11,413 |
| 1907–08 | ... | 14,322 | ... | 26,885 |
| 1908–09 | ... | 14,520 | ... | 41,232 |
| 1909–10 | ... | 23,180 | .. | 60,445 |
| 1910–11 | ... | 49.454 | ... | 168,620 |
| 1911–12 | ... | 74,498 | ... | 236,759 |
| 1912–13 | ... | 93,575 | ... | 254,359 |
| 1913–14 | ... | 99,924 | ... | 317,689 |

All the cotton is not ginned in the country at present, as in the year 1913-14 the actual exports of ginned cotton were 85,216 cwt. valued at £272,367, whilst 44,126 cwt. of unginned or seed-cotton valued at £45,322 were exported to British East Africa to be ginned and baled there. Some thousands of tons of cotton seed are also exported annually.

In the early days various kinds of cottons were grown, sold, ginned, and baled indiscriminately mixed together, so that complaints on the home markets were very frequent, whilst the shortage of storage accommodation and bad methods of handling were responsible for a large amount of stained and dirty cotton being exported which was extremely difficult to sell.

Numerous experiments were carried out with various varieties of cotton which resulted in long-stapled Upland American varieties being ultimately selected as best suited to form the basis of Uganda cotton, and all other cottons have been discarded.

Work is still going on in acclimatizing and grading up a suitable cotton, with highly gratifying results.

Better methods of handling are being gradually introduced, more storage accommodation provided, and cotton ginneries erected in the heart of the producing districts. It is hoped by these means, aided by improved transport facilities, to lessen very considerably the quantity of stained and dirty cotton shipped from Uganda.

Work on one of the Government plantations is almost entirely given up to the improvement of Uganda cotton by selection, and the seed thus produced is sown in restricted areas until ultimately sufficient is obtained for the whole of the country's seed distribution. The seed supply is entirely in the hands of the Government, and each season's sowing is done with the highest quality of seed obtainable, and which has been grown only in a specially selected area.

Cotton growing is purely a native industry and the large exports are due entirely to the thousands of small cultivators throughout the country.

The yield varies greatly according to the district and the season. In parts of the Buganda Province a yield of 300 lb. to 400 lb. of seed-cotton per acre is common, although in the Bulemezi County the yield is higher, whilst in the Eastern Province 600 lb. of seed-cotton per acre is a moderate estimate in an average season.

Large numbers of native instructors are at work throughout the Protectorate teaching the peasants how to cultivate and handle this crop, and it is hoped by this means to eliminate many of the complaints incidental to the starting of a new industry.

All the cotton seed is distributed free of charge to the growers, and now the quantity exceeds 300 tons per annum, the distribution of which entails a large amount of labour and organization.

Uganda cotton is of good quality and sells regularly at from 50 to 150 points on Middling American.

Legislation has been passed with a view to improving and maintaining a higher standard in Uganda cotton production, dealing with the distribution of seed, uprooting of plants, hand cotton gins, licences and permits to purchase raw cotton, markets, inspection of raw cotton and ginning factories, etc. A copy of the rules in force is given below:—

(As published in the *Uganda Official Gazette* of July 31, 1913, page 311.)

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## THE UGANDA COTTON ORDINANCE, 1908,

AND

## THE UGANDA COTTON (AMENDMENT) ORDINANCE, 1910.

### RULES.

### THE UGANDA COTTON RULES, 1913.

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I. These Rules may be cited as "The Uganda Cotton Rules, 1913."

II. Cotton seed (for sowing purposes) shall be distributed by the Government at such times and places and by such persons as the Governor shall prescribe.

III. No person shall grow cotton from seed which has been obtained from any other source than the Government.

IV. All cotton plants shall be uprooted and destroyed after the first season's crop has been picked therefrom, and on no account shall they be allowed to remain for a second season, or for more than one year in the ground.

V. The Director of Agriculture may from time to time fix by notification in the *Official Gazette* a date prior to which all the previous season's cotton plants shall be uprooted and destroyed in any district and all such plants shall be uprooted and destroyed prior to such date.

VI. No person owning or possessing a hand cotton gin shall use or permit the same to be used unless and until it is registered at the Office of the Department of Agriculture.

Every hand cotton gin in actual use shall be registered annually during the month of October.

VII. All cotton seed obtained from hand cotton gins shall forthwith be destroyed by the person so obtaining it or by any person into whose possession or ownership such seed shall come.

Provided always that it shall not be necessary to destroy such seed pending its being supplied to the Government, or exported or being treated in some manner which will prevent it being used as seed for growing purposes.

The burden of proof that such seed is to be so supplied, exported or treated shall be upon the person owning or possessing such seed.

VIII. The Director of Agriculture, or such other person or persons as may be authorized by him in that behalf, may grant licences for the purchase of raw cotton within the Protectorate, and no person shall purchase raw cotton within the Protectorate except under such a licence or under a permit granted by the holder of such a licence as hereinafter specified.

IX. Such licence and permit shall be in the forms set out in the schedule hereto or to the like effect.

X. It shall be lawful for the holder of a licence to grant and issue permits for the purchase of raw cotton to his agents or other persons employed by him.

Provided always that the names of all persons to whom the holder of a licence proposes to issue permits shall be submitted previously to the District Commissioner within whose district the holder of a permit intends to purchase raw cotton, and no such permits shall be issued unless and until the approval of the District Commissioner in writing has been received.

XI. In case any holder of a licence shall be convicted of a breach of the Uganda Cotton Ordinance, 1908, it shall be lawful for the Director of Agriculture to suspend or cancel such licence. In such case all permits issued under such licence shall become void, but the holder of a licence thus suspended or cancelled shall have the right of appeal to the Governor.

XII. No fee shall be payable in respect of any licence to be issued under these rules; but the holder of a licence shall pay in respect of every permit issued by him a fee of one rupee to the District Commissioner at the time approval for the issue of such permit is obtained.

XIII. The Governor may by notification in the *Official Gazette* fix places in any part of the Protectorate for the purchase and sale of raw cotton and it shall not be lawful for any person to buy or sell raw cotton within such part except at such places.

XIV. The Governor may by notification in the *Official Gazette* fix certain areas within which the purchase and sale of raw cotton shall be unlawful except subject to such conditions as may be prescribed in such notification.

XV. All raw cotton and every ginning factory may be inspected at any reasonable time by an officer of the Department of Agriculture.

XVI. Any breach or attempted breach or non-observance of any of the above rules shall be punishable by imprisonment of either description for a term not exceeding one month or by a fine not exceeding one thousand rupees or by both, and any cotton, cotton seed or hand cotton gin in respect of which any such breach attempted breach or non-observance has been committed may be confiscated or otherwise dealt with, with or without compensation.

XVII. The Uganda Cotton Ordinance Rules, 1909, and The Uganda Cotton Ordinance Rules (No. 2), 1909, are hereby repealed.

(Signed) F. J. JACKSON,
*Governor.*

Entebbe,
July 17, 1913.

## SCHEDULE.

*Form of Licence (in English only).*

UGANDA PROTECTORATE.

*No......*

DEPARTMENT OF AGRICULTURE.

*Licence to Purchase Raw Cotton.*

*Issued under the Uganda Cotton Rules,* 1913.

..........................................................................................

...............is hereby licensed to purchase Raw Cotton within the Uganda Protectorate during the year 19...... and, with the approval of a District Commissioner, to grant permits for the purchase of Raw Cotton to his agents or other persons employed by him not exceeding a total number of.................permits.

..............................................

*Director of Agriculture.*

Kampala, Uganda,

.................19......

*Form of Permit (in English and Luganda).*

UGANDA PROTECTORATE.

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*Permit to Purchase Raw Cotton.*

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Station.................. No...............

A permit to purchase Raw Cotton within the..........................
District is hereby granted to..................................................
of..................................under Licence No...................for the
year 191.........

..................................................

*Holder of Licence.*

Fee : R. 1.

Approved :

..................................................

*District Commissioner.*

....................191......

....................................

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## COTTON POSSIBILITIES IN ITALIAN SOMALILAND AND JUBALAND (BRITISH EAST AFRICA).

By Dr. R. Onor.

*Director of Agriculture, Italian Somaliland.*

The production of long-stapled cotton of Egyptian type is almost a privilege of Egypt, and the attempts to grow it elsewhere do not seem to have attained noteworthy practical results. The strong position of Egypt in the cotton market is founded on the quality of the product more than on the quantity.

The British West Indies and America grow the best long-stapled cotton, "Sea Island," but its production is limited, and a great increase in the future is not to be expected.

As far as length of staple is concerned, American cultivators by careful selection obtained very good results with Upland long staple, but it does not seem probable that this type will interfere with the commercial position of Egyptian cotton.

It is therefore of some interest to know the possibilities of growing Egyptian cotton in a country almost practically unknown, viz., Italian Somaliland and the land bordering the Juba river, both on the British East Africa side and on the Italian side.

It is not incorrect to say that if all plants have special climatic requirements, Egyptian cotton asks for very peculiar ones. Perhaps no other annual cultivated plant needs for its full development so much heat. Therefore even in hot countries the cycle of vegetation of such a plant is likely to be a very long one. Egyptian cotton wants hot weather during the early growing period to induce a rapid development of the plant, while a high temperature must prevail for some months to bring about full production. It happens sometimes in Egypt that a low temperature in autumn prevents the ripening of the last pickings, and the crop is therefore much reduced.

Another very important condition is the distribution of water in relation to the various growing periods of the plant. Too much water during the early stages of growth—as is the case when rains are very abundant and continuous—produces an excessive vegetative growth, injurious to the crop, whilst rain during the opening of the bolls considerably deteriorates the quality of the fibre.

An unfavourable distribution of the rainfall is also responsible for other serious damages. Cotton is a plant susceptible to the attacks of many insect pests. And as it must occupy the land for a great length of time during hot weather insect pests can easily produce many generations, and reach such large numbers as to diminish enormously the quantity and quality of the product.

The chief determining factor of the spread of parasites is humidity accompanied by high temperatures. In tropical countries frequent rains are to be considered much more dangerous than useful to the cotton cultivator.

For all plants, but especially for Egyptian cotton, we may say that a particularly rigid rule should be followed in the supply of the water, and—unless under favourable climatic conditions, with a rainfall naturally distributed in accordance with the requirements of the cotton plant —that can be attained only in arid regions and by irrigation.

The country we intend to refer to—Italian Somaliland and Jubaland—is likely to be well suited to cotton cultivation. The climate is uniform. The average temperature throughout the year varies between 73° F. in the night and 88° F. in the day.

There are two rainy seasons, the first in April-May, and another in October-November, but the average yearly rainfall (from 12 to 25 in.) cannot be relied on, being very uncertain and only exceptionally sufficient for the full and normal development of the cotton plant.

It is then necessary to provide irrigation.

Two rivers exist in the country, the Uebi-Scebeli, flowing in its lowest portion parallel to the coast of Italian Somaliland at an average distance of ten miles from it, and the Juba river, forming the boundary between Italian Somaliland and British East Africa.

The Juba river, which is supposed to have a discharge of about 600 cubic metres per second during high-water period, has a principal flood in October-November. In this season it is possible to obtain water directly for irrigation purposes in some places, or to pump it at a small height of lift. From the end of April until October it is necessary to get water by pumping it.

The Uebi-Scebeli river has two periods of flood, the first one from the last days of April until June, and another from the beginning of September until December. For about five months in the year it is possible to get irrigation water directly. The Uebi-Scebeli during flood has a discharge of about 60 cubic metres per second, which is reduced to about one-half during July and August.

From December to April the discharge of both rivers falls until it becomes of no importance.

The dry season is very advantageous for cotton cultivation. It affords good conditions to the full ripening of bolls, without danger of the fibre being injured by rains, interrupts the propagation of the parasites, allows a very long picking period, leaving time for the eradication and burning of plants infested with insect pests and their eggs and for a good preparation of soil under the best conditions.

The deep, flat, alluvial soils of the country—most of which are of a clayey nature—are very good, and compare favourably with the best Egyptian soil. The average percentage of the essential plant foods are as follows:—

| | |
|---|---|
| Nitrogen ... ... ... ... | 0·10 |
| Potash ... ... ... ... ... | 0·80—1·50 |
| Phosphoric acid ... ... ... | 0·10 |
| Organic matter ... ... ... | 10·00 |

Italian Somaliland and Jubaland are almost new countries. Only three years ago a few European farms were started on the English and Italian sides of the Juba river, and some thousand bales of good cotton have already been shipped to Europe.

The agricultural season can be considered as beginning about the end of April, since at this time rivers begin flooding and enable direct irrigation or easy pumping of water to be carried on. About that time also abundant rain falls which allows the sowing of cotton without irrigation.

By sowing in May, and under a normal vegetation of the plant, Egyptian cotton shows the first opening bolls after 140 days, so that picking begins in October and can be profitably continued until February.

During October-November some showers may come disturbing picking, but heavy rains rarely occur, and in any case the sun and wind rapidly dry the bolls, so that the damage complained of in other countries through wetting of the bolls is avoided.

The deep clay soil retains water for a long while, and under these circumstances it is advisable to give only a few heavy irrigations, followed by careful tillage to keep the soil soft and permeable.

In clay soils, and especially in hot countries, where the high capillary power and cracking and shrinking on drying are extreme, it is very important to keep a fine surface tilth, and the error commonly met with in temperate countries, that lack of tillage may be compensated by giving more irrigation water than usual, must be avoided.

The culture system to be followed may be regarded as a combination of *dry farming and irrigation.*

In fact, light irrigations cannot penetrate deeply in the soil so long as high temperature and strong winds cause great evaporation, and since the water in some seasons. especially on the Uebi-Scebeli, deposits a good deal of fine silt, and also on account of the necessity of tillage, as mentioned, it would be necessary to provide hoeing after each watering, the net result being an increase in the cultivation expenses.

Therefore what may be correct in temperate countries, viz., *moderate quantity of water frequently supplied*, is likely to be changed, and under the conditions stated it is better to give heavy waterings at comparatively long periods, and to avoid loss of moisture by careful tillage.

On the basis of these principles, if Egyptian cotton is sown in May after a good rain, which ordinarily occurs, or after a heavy irrigation, about forty days must elapse before another watering is given, so that the plants can root well and deeply. About a month afterwards another heavy irrigation must be given, which is usually regarded as sufficient to permit the plant to come to maturity. One more watering may be profitable in September before the ripening of the bolls, but this is not always advisable, because, if the plant does not show real need of water, irrigation may induce a late luxuriant vegetative growth and shedding of bolls, as well as encouraging the spread of insect pests and retarding the ripening of the crop.

It is advisable, however, to apply water after the first picking, as by this means the plant is encouraged to produce a vigorous vegetative growth and picking may be continued during the dry season until the end of February, when it is necessary to root out and burn the plants to check the development of parasites.

Experiments made by the Italian Government have shown that the common varieties of Egyptian cotton such as Afifi, Abassi, Sakellaridis, and Jannovitch, attain a very considerable size, so that a distance of 3 ft. or more between the rows and 2½ ft. between the plants in the row is not excessive.

Under favourable conditions, that is to say with sufficient application of water, and when insect pests are not encouraged to spread by small showers during June and July, more than 600 lb. of lint per acre have been obtained.

The cotton produced by farmers on the Juba river attains a length of about 1½ in. and more, and has been classed with good Egyptian qualities.

Of course, in a tropical country like that we are speaking about, one encounters most of the problems commonly met with in such regions. The country is quite suitable for white people, since ordinary tropical diseases do not exist there, and the climate is very good and not at all hot, owing to the monsoons blowing almost all the year. But cattle cannot be employed on account of the presence near the rivers of the tsetse-fly. It is therefore necessary to have recourse to some mechanical implement for field work, but motor traction and motor culture have made such progress that among the various kinds offered by manufacturers one can generally find the machinery suitable for every requirement. The labour problem also is one met with now in most colonies, and in the country we have spoken of it is neither easier nor harder than in many other regions.

In view of the endeavours to find new lands suitable for the production of cotton of the Egyptian type, it will not have been without interest to have called attention to Italian Somaliland and Jubaland as countries worthy of the hopes based upon them.

# LA COLTIVAZIONE DEL COTONE E L'ALLEVAMENTO DEL BESTIAME NELLA SOMALIA ITALIANA MERIDIONALE.

Per il Dott. GIUSEPPE SCASSELLATI-SFORZOLINI.

*Dell' Istituto Agricolo Coloniale Italiano.*

## 1º COLTIVAZIONE DEL COTONE IN SOMALIA.

### L'AMBIENTE NATURALE SOMALO PER LA COLTIVAZIONE DEL COTONE.

LE condizioni naturali che la nostra Colonia dell'Oceano Indiano presenta nelle sue immense vallate alluvionali del Giuba e dell'Uebi Scebeli, sono ottime per una estesa coltivazione di cotone, sia che si considerino i terreni ed il clima della regione, sia che si pensi alla possibilità tecnica di rendere facilmente irrigabili grandi estensioni di terreno.

#### *Terreni.*

I terreni della Somalia[1] sono nella enorme maggioranza ricchissimi, sia fisicamente che chimicamente. Essi presentano scarsissimo scheletro: sono argillosi, compatti, di colore prevalente avana scuro e spesso scurissimo, per la ricchezza di humus, sono paragonabili ai "*ton*" egiziani, compatti, spessi, neri, profondi 5 o 6 metri, ottimi per il cotone.

Esistono, nelle zone relativamente lontane dai fiumi, terre meno argillose, contenenti discreta quantità di sabbia, meno compatte e humifere, di colore rossastro. Sono esse riferibili ai "*lehm*," che pure abbondano in Egitto.

I terreni somali sono sempre forniti delle sostanze indispensabili alla vita delle piante.

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[1] Mi riferisco sempre ai terreni agrari delle vallate alluvionali ed ai campioni di essi, prelevati a circa m. 0·20 dalla superficie del suolo.

*Risultati medi*[2] *dell'analisi chimica di circa* 90 *campioni di terre somale delle vallate alluvionali* (*riferiti a* 100 *gr. di terra fina*).

| | Quantità media | Quantità massima | Quantità minima |
|---|---|---|---|
| 1° Sostanza organica ... | 8·820 | 15·902 | 1·400 |
| 2° Acqua a 110° ... | 7·012 | 9·704 | 0·627 |
| 3° Ossido di calcio ... | 7·613 | 13·962 | 0·985 |
| 4° Anidride fosforica ... | 0·123 | 0·588 | 0·036 |
| 5° Ossido di potassio ... | 0·960 | 1·970 | 0·039 |
| 6° Azoto totale ... | 0·134 | 0·336 | 0·033 |

*Risultati medii dell' analisi chimiche di circa* 90 *campioni di terre somale delle vallate alluvionali* (*riferiti ad un ettaro e ad uno strato di m.* 0.15).

| | | |
|---|---|---|
| Peso di un litro di terra somala ... ... | Kg. | 1·380 |
| Peso di uno strato di terra somala di m. 0·15 dell'estensione di un ettaro .. ... | Tonn. | 2,070·000 |
| 1°) Sostanza organica ... ... ... | ,, | 182·574 |
| 2°) Acqua a 110° ... ... ... | ,, | 145·148 |
| 3°) Ossido di calcio ... ... ... | ,, | 157·589 |
| 4°) Anidride fosforica ... ... ... | ,, | 2·546 |
| 5°) Ossido di potassio ... ... ... | ,, | 19·872 |
| 6°) Azoto totale ... ... ... | ,, | 2·773 |

*Alimenti minerali, che un raccolto di cotone netto di* 400 *Kg. per ettaro, sottrarrebbe in media dal terreno* (per mezzo delle sue diverse parti, supponendo che queste ne vengano completamente asportate).

| | Peso secco | Azoto | Acido fosforico | Potassa | Calce | Magnesia |
|---|---|---|---|---|---|---|
| Cotone (fibra) ... | 400 | 1·36 | 0·40 | 1·84 | 0·76 | 0·32 |
| Semi ... | 872 | 27·28 | 11·08 | 10·20 | 2·20 | 4·80 |
| Capsule ... | 540 | 13·72 | 5·20 | 9·76 | 2·76 | 2·16 |
| Foglie ... | 768 | 24·64 | 9·12 | 13·84 | 34·08 | 6·68 |
| Steli ... | 876 | 12·80 | 5·16 | 12·36 | 8·48 | 3·68 |
| Radici ... | 332 | 3·04 | 1·72 | 4·24 | 2·12 | 1·36 |
| Totale Kg. | 3,788 | 82·84 | 32·68 | 52·24 | 50·40 | 19·00 |

Dall' esame comparativo delle due ultime tabelle resulta evidente la grande richessa delle terre somale (soprasuolo) e la possibilità di coltivare ripetutamente il cotone anche sensa concimazioni.

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[2] Parte dei campioni furono prelevati dall'A.e fatti analizzare dal Dr. Umberto Misuri e dal Dr. Augusto Gaiter.

Altri campioni furono raccolti dal Dr. Macaluso ed analizzati dal Dr. W. Rossi (*Agricoltura Coloniale,* Anno III, N° 2, 1909).

Altri terreni poi furono raccolti dal Dr. G. Mangano (*Agricoltura Coloniale,* Anno III, N° 6, 1909).

Anche in Somalia, come in Egitto ed altrove, notevole è la quantità di sali solubili esistenti nel terreno: questi non ostacolano la coltura del cotone, anzi una piccola quantità di sale, secondo il Foaden, deve influire favorevolmente sulla resistenza e sul colore della fibra.

## *Clima.*

Certi elementi del clima possono rassomigliarsi a quelli dell'Egitto e degli altri paesi cotonieri, mentre altri elementi diversificano notevolmente, non risultando però mai sfavorevoli alla coltura del cotone.

*Tabella delle temperature.*[3]

| Mesi | della Somalia | | | della Valle del Nilo | dell 'America del Nord | | |
|---|---|---|---|---|---|---|---|
| | media | minima | massima | media | Stati del Nord (medie) | Stati del centro (medie) | Stati del Sud (medie) |
| Gennaio ... | 26·6 | 21·5 | 31·6 | — | — | — | — |
| Febbraio ... | 26·9 | 21·9 | 32·0 | — | — | — | — |
| Marzo ... | 28·0 | 22·9 | 32·4 | — | — | — | — |
| Aprile ... | 27·5 | 22·9 | 32·1 | 20·01 | 16·1 | 17·3 | 20·9 |
| Maggio ... | 26·6 | 22·0 | 31·1 | 26·50 | 20·7 | 21·6 | 24·1 |
| Giugno ... | 25·5 | 21·1 | 29·9 | 28·99 | 24·8 | 25·5 | 27·4 |
| Luglio ... | 24·6 | 20·3 | 28·9 | 29·88 | 26·4 | 27·2 | 28·5 |
| Agosto ... | 24·6 | 20·1 | 29·1 | 29·43 | 25·2 | 26·4 | 27·8 |
| Settembre | 25·4 | 20·9 | 29·8 | 25·84 | 21·8 | 23·6 | 25·7 |
| Ottobre ... | 26·1 | 21·8 | 30·6 | 23·01 | 16·8 | 18·4 | 21·3 |
| Novembre... | 26·4 | 21·9 | 30·9 | 18·51 | 9·8 | 13·1 | 16·3 |
| Dicembre ... | 26·4 | 22·1 | 31·3 | — | — | — | — |
| Annuale ... | 26·3 | 21·6 | 30·7 | — | — | — | — |

[3] Le cifre della tabella, per ciò che riguarda la Somalia, rappresentano le medie delle temperature registrate negli anni 1910, 1911, 1912, in 6 stazioni meteorologiche, situate, tre sulla costa: Giumbo, Brava, Mogadiscio, e tre nell' interno: Balad, Afgoi e Bardera. I dati climatici riguardanti la Somalia, elaborati da dall'A., sono stati desunti dal lavoro del Prof. F. Eredia: " Sul clima della Somalia Italiana Meridionale."

I dati metereologici riguardanti l'Egitto ed il Nord-America, sono stati desunti dal lavoro del Prof. A. Zimmermann: " Anleitung für die Baumwollkultur in den Deutschen Kolonien, Berlin, 1910."

*Tabella delle precipitazioni (in mm.).*

| Mesi | In Somalia | | | | | | In Egitto | | Nel Nord America | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Regioni dell' interno | | | Regioni costiere | | | | | | | |
| | Afgoi | Balad | Bardera | Brava | Giumbo | Mogadiscio | Cairo | Ales-sandria | Località dell' Oceana Atlantico Orientale | Località del Golfo Occiden-tale | Vallata del Rio Grande |
| Gennaio ... ... .. | — | — | 5·2 | — | — | — | 5·6 | 47·2 | 107 | 96 | 31 |
| Febbraio ... ... ... | — | 2·0 | — | 1·0 | — | — | 2·5 | 16·0 | 91 | 86 | 27 |
| Marzo ... .. ... | 2·5 | 60·0 | 10·1 | 1·0 | — | — | 3·0 | 24·9 | 110 | 95 | 28 |
| Aprile ... ... ... | 180·3 | 363·0 | 148·1 | 190·7 | 39·3 | 143·0 | 2·5 | 1·8 | 98 | 100 | 17 |
| aggio ... ... ... | 53·5 | 15·0 | 41·9 | 25·2 | 136·9 | 57·2 | 0·3 | 1·3 | 95 | 119 | 69 |
| Giugno ... ... ... | 38·0 | 9·5 | 1·9 | 7·0 | 30·1 | 26·8 | — | — | 130 | 96 | 54 |
| Luglio ... ... ... | 94·0 | 17·0 | 8·3 | 39·9 | 24·2 | 55·8 | — | — | 147 | 95 | 40 |
| Agosto ... ... ... | 38·3 | 37·0 | 2·8 | 11·7 | 11·3 | 14·6 | — | — | 161 | 73 | 78 |
| Settembre ... ... ... | 3·0 | 24·0 | — | 3·3 | 9·2 | 15·2 | — | 2·3 | 133 | 133 | 150 |
| Ottobre ... ... ... | 13·3 | 6·2 | 16·1 | 7·0 | 0·1 | — | — | 2·8 | 104 | 105 | 80 |
| Novembre ... ... ... | 103·0 | 146·8 | 133·2 | 9·0 | 18·5 | 13·0 | 16·2 | 45·0 | 97 | 112 | 41 |
| Dicembre ... ... ... | 38·6 | 84·5 | 38·0 | 8·3 | 0·7 | — | 7·9 | 56·9 | 103 | 104 | 39 |
| Annuale ... ... | 564·5 | 765·0 | 405·6 | 304·1 | 270·3 | 325·6 | 38·0 | 198·2 | 1,358 | 1,219 | 654 |

Il clima è caldo in tutto l'anno; limitata è la variazione di temperatura nei vari mesi e pur lieve è la differenza fra le temperature massime e minime sia diurne che mensili inconfronto aquella di altre regioni tropicali. L'andamento della temperatura in Somalia risulta favorevolissimo alla coltura del cotone.

In Somalia normalmente piove poco: piove molto di più che in Egitto, molto meno che nel maggior numero degli Stati cotonieri del Nord America (se si eccettua la regione del Rio Grande). Nelle regioni interne della nostra Colonia si registrano maggiori precipitazioni che nelle regioni costiere.

*Precipitazioni annue (in mm.) in alcune regioni dell'Africa Orientale Inglese e Tedesca.*

Africa Orientale Inglese (medie di sei anni d'osservazioni)

| | | | |
|---|---|---|---|
| Stazione di Kisimayo | Regione costiera ... | mm. | 432 |
| ,, ,, Malindi | | ,, | 1235 |
| ,, ,, Mombasa | | ,, | 1467 |
| ,, ,, Mazeras | Regione dell' interno | ,, | 1525 |
| ,, ,, Nairobi | | ,, | 910 |
| ,, ,, Naiwasha | | ,, | 943 |
| ,, ,, Port Florence | | ,, | 1223 |

Africa Orientale Tedesca

| | | | |
|---|---|---|---|
| Stazione di Tanga | Regione costiera ... | ,, | 1460 |
| ,, ,, Daressalam | | ,, | 1140 |
| ,, ,, Lindi | | ,, | 800 |

Differenze molto forti esistono, come si vede, fra le precipitazioni somale e quelle delle vicine colonie inglese e tedesca, ove in generale piove molto di più.

In queste regioni però non prospera generalmente la coltivazione del cotone.

L'umidità relativa dell'aria è, in Somalia, molto più elevata che in Egitto e ciò determina, per la nostra Colonia, una condizione di favore nei riguardi del cotone.

I venti dominanti sono i monsoni, che spirano tutto l'anno dall'Oceano Indiano, con direzione di Sud-Ovest (monsone più violento) da aprile a ottobre, e di Nord-Est (monsone meno violento) da ottobre ad aprile. La violenza dei venti va diminuendo quando dalle regioni costiere si procede verso quelle dell' interno, dove sono pure attenuati i danni che il vento può arrecare alle coltivazioni di cotone.

*Tabella dell'umidità relativa.*

| Mesi | Somalia | | | Egitto |
|---|---|---|---|---|
| | Brava | Giumbo | Mogadiscio | |
| Gennaio ... | 74 | 80 | 91 | 41 |
| Febbraio ... | 73 | 81 | 80 | 34 |
| Marzo ... | 70 | 79 | 82 | 34 |
| Aprile ... | 72 | 79 | 86 | 30 |
| Maggio ... | 77 | 83 | 85 | 25 |
| Giugno ... | 74 | 81 | 87 | 32 |
| Luglio ... | 75 | 82 | 89 | 33 |
| Agosto ... | 70 | 82 | 87 | 44 |
| Settembre ... | 73 | 82 | 89 | 44 |
| Ottobre ... | 73 | 82 | 90 | 46 |
| Novembre ... | 72 | 82 | 90 | 53 |
| Dicembre ... | 73 | 81 | 99 | 53 |
| Annuale... ... | 73 | 81 | 87 | 39 |

*Regime dei Fiumi.*

Il Giuba è in massima piena a novembre: il livello delle acque aumenta ai primi di ottobre e diminuisce verso la metà di dicembre. Fa seguito la massima magra in gennaio e febbraio, quindi la piccola piena di aprile, dopo la quale, fino a settembre, le acque si mantengono sempre basse.

Analogo è il regime dell'Uebi Scebeli: soltanto che per questo fiume la piena di aprile si prolunga per tutto maggio ed assume una importanza maggiore di quella che ha per il Giuba.

Le acque dei fiumi, straripando, trasportano sospesa una notevole quantità di limo fertilizzante, che potrà aumentare continuamente le ricchezze di quelle terre.

*Analisi di un campione di limo dello Scebeli prelevato durante la piena del maggio* 1911.[4]

| | Limo dello Scebeli | Limo del Nilo |
|---|---|---|
| Scheletro ... ... ... ... | 20 | — |
| Terra fina (sotto mm. 1) ... ... ... | 980 | — |
| Umidità ... .. ... ... | 68·20 | — |
| Sostanza organica (perdita a fuoco) ... ... | 140 | 88·20 |
| Calcare ... ... ... ... | 2·5 | 30·07 |
| Anidride fosforica totale ... ... ... | 2 | 2·50 |
| Ossido di potassa solubile in HCl al 25% ... | 6·50 | 5·30 |
| Azoto ... ... ... ... ... | 0·90 | 1·40 |
| Levigazione con mm. 0·2 di velocità per secondo. | | |
| Sabbia greggia ... ... ... ... | 750 | — |
| Argilla ... ... ... ... ... | 250 | — |

Gl'indigeni della Somalia dividono l'anno in periodi, come segue: —

*Tabella con i periodi dell'anno somalo.*

| Denominazione indigena del periodo | Mesi | Temperatura | Pioggie | Venti | Regime dei fiumi |
|---|---|---|---|---|---|
| 1°) Gilal ... ... | Dicembre<br>Gennaio<br>Febbraio | Molto caldo | Secco | Monsone di S-O (molto violento) | Periodo di grande magra |
| 2°) Gu ... ... | Marzo<br>Aprile<br>Maggio | Caldo | Grandi pioggie | Cambiamento del monsone | Periodo della piccola piena |
| 3°) Haret o Hagai | Giugno<br>Luglio<br>Agosto | Fresco | Pioggie scarse | Monsone di N-E (meno violento) | Periodo della piccola magra |
| 4°) Der ... ... | Settembre<br>Ottobre<br>Novembre | Caldo | Piccole pioggie | Cambiamento del monsone | Periodo della grande piena |

## Qualche Notizia sugli Esperimenti di Cotone Eseguiti Fino ad Ora in Somalia.

Primo fra tutti fu il Carpanetti nel 1906 a seminare cotone nella piana di Torda (Yubaland Italiano). Egli esperimentò con vero successo cotoni egiziani (Abassi ed Afifi) ed americani (a lunga fibra) su circa 7 ettari di superficie. Le varietà Abassi ed Afifi fornirono prodotti ottimi per qualità e quantità, e così accadde delle varietà americane.

[4] Assumo questi risultati dal rapporto del Dott. Onor, posto in appendice della Relazione sulla Somalia Italiana, presentata dal Gov. Sen. G. De Martino al Ministro delle Colonie, 1912.

Nel 1907 il Carpanetti stesso ripetè a Bieya e a Bulo Boda (Yubaland Italiano) i suoi esperimenti di cotone, ma ebbe le colture danneggiate dalla insistente siccità.

Nel 1908 si iniziarono a Bieya ed a Elvalda ed in seguito a Margherita (tutte località dello Yubaland Italiano) e ad Avai (sullo Scebeli) vaste coltivazioni di cotone per opera di concessionari italiani. Si ottennero sempre risultati ottimi dal punto di vista della qualità e quantità del prodotto, anche quando il tornaconto non arrise al coltivatore inesperto. Presto si cessò di coltivare cotone ad Elvalda e ad Avai, mentre tuttora prosperano le colture di Margherita e di Bieya.

In tutte queste località si adoperarono cotoni egiziani (Abassi, Afifi, Janovitch, Sakellaridis) ed Americani upland. Si seminò normalmente in maggio e giugno e si raccolse a novembre-dicembre. Il cotone ebbe le acque di pioggia e quelle di parecchie irrigazioni. Si ottennero in media circa Kg. 1,000 di prodotto lordo per Ettaro, che fornirono circa Kg. 350 di ottima fibra.[5]

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Molestarono le colture di cotone parecchie avversità nemiche, quasi tutte prodotte da animali. Risultarono molto dannosi: —

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[5] Ecco alcuni giudizi di talune fra le più importanti Ditte cotoniere su alcuni campioni di Abassi, spediti nel 1910 dal Dott. Lanzoni da Bieya (Yubaland Italiano): L'On. Silvio Crespi scriveva: "Il cotone è veramente magnifico, pari alle più belle qualità di prodotti egiziani ed anzi superiore per lucentezza." La Ditta Gussoni di Milano: "È difficile stabilire il prezzo di una così bella qualità, adatta per speciali lavori come velluti." La Ditta Somaini di Lomazzo: "È roba che in nessuna parte del mondo si produce migliore." Le Industrie Tessili Napoletane: "È con vivo piacere che Vi dichiariamo che abbiamo trovato il Vostro cotone del Benadir veramente splendido per tiglio, seta e colore, e tale da sostenere vantaggiosamente il confronto coi migliori cotoni di produzione egiziana." La Ditta S. C. Woolley Eso di Cairo: "Qualità magnifica, specialmente per il colore e lucentezza, consiglia la vendita a Liverpool per far conoscere questa splendida qualità di cotone." L'Association cotonnière di Parigi: "Qualità Abassi = fully good middling—creaurg brillant, resa regolare e nervosa, valore frs. 115 per 50 ks." L'Ing. Fedele Bonghi di Legnano: "La fibra è d'ottimo aspetto e raggiunge una lungh. mass. di 36 mm."

1° Il verme rosso delle capsule (*Gelechia gossypiella*).

2° Le cicale verdi del cotone (kränselkrankheit o malattia del raggrinzamento delle foglie).

Risultarono poco dannosi: —

1° Il verme del cotone degli americani (*Heliothis armiger* o *peltiger?*). Fu notato dal Dott. Onor nel giugno del 1911 nei campi di cotone di Bieya, ma il parassita non produsse i gravi danni, che produce altrove.

2° La cimice rossa del cotone (parecchie specie di *Disdercus*).

3° La piccola cimice scura del cotone (*Oxicarenus hyalinipennis?*).

* * *

Nello Yubaland inglese, tralasciando di parlare degli esperimenti del Sig. E. Brand, si iniziarono nel 1911 le prime prove di cotone. Appunto in quell'anno il Sig. Agiropolo coltivò ad Halwalood 15 acri a cotone, ottenendo ottimo prodotto.

Ad Alessandra, dirimpetto alla nostra Gelib sul Giuba, il vice commissario inglese Sig. Filleul eseguì nel 1911 un esperimento su di un acre di terreno, seminando varietà Abassi nel mese di maggio. In questo mese ed in quello di giugno caddero circa 375 mm. di pioggia. Nei quattro mesi seguenti irrigò quattro volte l'appezzamento. Eseguì la raccolta in novembre, ottenendo oltre 896 Kg. di ottimo prodotto (circa 300 Kg. di fibra).

* * *

Sempre nel 1911 il Dott. Onor, per conto del Governo della Somalia Italiana, eseguì a Kaitoi (sullo Scebeli, vicino a Merca) dei saggi colturali delle principali piante che possono interessare quella regione.

Si sperimentarono fra l'altro le seguenti varietà: —[6]

1° Cotone indigeno.—Produce fibra scarsa e corta: ha però una grande resistenza alla siccità e malattie e potrà in seguito ibridarsi con varietà più pregiate.

2° Varietà egiziane (Afifi, Sakellaridis, Abassi).—Si seminarono in fine maggio e primi giugno, adottando le distanze di 0·90 × 0·60 e di 1·20 × 0·70. Si posero per ogni buca da sei a otto semi, lasciando poi due piantine

[6] Vedi Rapporto del Dott. Onor s.c.

per linea. Le prime capsule cominciarono a schiudersi ai primi di ottobre. Il ciclo vegetativo del cotone egiziano dalla semina al primo raccolto durò circa 140 giorni. Da circa 5,800 mq. di superficie ad Afifi si ottennero 459 Kg. di fibra, il che corrisponde al rendimento elevato (non ottenibile certo in media nella grande coltura) di 790 Kg. per ettaro.

3° Cotoni Upland.—Si seminarono le seguenti varietà: Ely's Triumph, Allen's Long Staple, Thoroughbred Toole, Farmer's Friend, Toole's Ounce Boll, Cleveland Big Boll, Green Seeds, King, Cook, Mebane, nei primi di settembre e cominciarono a dar prodotto circa 120 giorni dopo. La semina, fatta in minuscoli campetti, andò poco bene.

4° Cotone Caravonica (varietà lana e seta).—Si sa soltanto che i pochi semi attecchiti diedero piante gigantesche, molto assalite dai parassiti animali.

Molti altri dati e risultati ci offre nel suo rapporto il Dott. Onor, riguardanti questi esperimenti di Kaitoi, che ebbero, a parer mio, due peccati di origine: —

1° Furono eseguiti su appezzamenti di terreno troppo piccoli, spesso addirittura minuscoli.

2° Ebbero troppo vicino l'Uebi Scebeli, che potè influenzare l'andamento normale delle colture.

I campetti di Kaitoi furono subito abbandonati, giacchè il Governo Coloniale decise nel 1912 di creare a Genale (sempre sullo Scebeli) una grande azienda agraria sperimentale, della quale si attendono i primi risultati.

Riassumendo, tutti gli esperimenti e colture di cotone fin qui eseguiti in Somalia hanno sopratutto dimostrato la *possibilità tecnica* di coltivare ottimo cotone, sia delle varietà egiziane, che di quelle americane upland.

Resterà a vedere quali elementi concorreranno a rendere *possibile anche economicamente* la coltura di questa pianta in Somalia.

## Qualche Considerazione Tecnica sulla Coltura del Cotone in Somalia.

### *Scelta delle Località Adatte e delle Varietà.*

In Somalia prosperano tanto i cotoni egiziani (Abassi, Afifi, Sakellaridis, Janovitch, etc.) ed americani sea island tutti a lunga fibra, irrigui, tardivi, esigenti, che i cotoni upland a fibra più o meno lunga, rustici, seccagni, precoci.

L'imbarazzo starà quindi nella scelta, fra tante varietà, di quella o quelle, che meglio prospereranno in determinate condizioni di terreno, di clima e di tempo.

1° Coltiveremo con vantaggio i cotoni egiziani e sea island, ogni qual volta avremo a disposizione, per un periodo lungo di tempo, notevole quantità d'acqua per l'irrigazione. Potremo avere l'acqua o mediante sollevamento meccanico dai fiumi (specialmente adatto nella regione dello Scebeli, ove la prevalenza da superare è piccola) o meglio con sbarramenti o dighe nel letto dei fiumi stessi, onde farla, come in Egitto, defluire dalle sponde ed incanalarla anche per grandi distanze.

2° In molte zone dello Scebeli ed in limitate anche del Giuba, si potrà, senza sbarramenti o sollevamento meccanico, irrigare i terreni durante i brevi periodi delle piene dei fiumi. Le acque, straripando dalle sponde sopraelevate sui terreni contermini, potranno irrigare naturalmente, ma per breve tempo, estese zone a cotone. Si coltiveranno, in questi casi, tipi upland long staple, che pur essendo abbastanza precoci e rustici, forniscono prodotti pregiati ed abbondanti (var. Allen's long staple, Griffin's long staple, Mattaw's long staple, etc.).

3° La Somalia presenta molte zone paludose, che prima o poi dovremo bonificare. In tutte queste plaghe fertilissime, che seguiteranno a mantenersi relativamente umide anche dopo il prosciugamento, prospereranno di certo gli upland a lunga o corta fibra e forse gli stessi cotoni egiziani, senza bisogno dell'irrigazione. Adattissima per terreni umidi e ricchi di humus è la varietà upland chiamata triumph (del tipo stormproos).

4° Nelle regioni costiere della Somalia pioye molto meno che in quelle interne, ove spesso cadono oltre 750 mm. di pioggia all'anno. In queste ultime zone potremo coltivare cotone seccagno delle varietà upland short staple, resistentissime alla siccità, come la Hawkin's extra prolific, la thoroughbred Russell, etc., o precocissime come la King's early improved, la Simpkin's early prolific, la green seed, &c.

Quindi, riassumendo, coltiveremo: cotoni egiziani e sea island nelle zone irrigabili artificialmente per lungo periodo dell'anno; cotoni upland long staple nei terreni irrigabili naturalmente durante i brevi periodi delle piene dei fiumi; cotoni upland short staple in coltura seccagna nelle zone umide e nelle regioni dell'interno dove piove abbastanza.

In tesi generale poi, le località più propizie al cotone saranno quelle un po' lontane dalla costa (alta Goscia e media valle dello Scebeli) ove piove di più, minor danno produce la violenza dei venti, piccola è la prevalenza da vincere per sollevare l'acqua dai fiumi, migliore è la qualità delle terre, più facile la loro sistemazione onde renderle irrigabili.

### *Epoca della Semina.*

In Somalia, benchè ci sia una grande uniformità di clima durante l'anno, sarà conveniente iniziare le colture in uno dei periodi di pioggia, che segnano come un risveglio nella vita vegetativa della regione, assopita dalla siccità del *gilal* e dell'*haret*.

1° Le varietà egiziane e le sea island si semineranno in *gu*, usufruendo dell'acqua delle grandi pioggie e poi di quella derivata artificialmente dai fiumi. Queste varietà tardive si cercherà seminarle prima che la stagione lo renderà possibile, affinchè le piccole pioggie del *der* non danneggino molto il prodotto maturo.

2° I cotoni upland potranno seminarsi in *gu* o in *der*, secondo dei casi.

(*a*) Semineremo in *der* gli upland long or short staple in tutte quelle zone irrigabili naturalmente dalle acque dei fiumi nei brevi periodi delle piene, o in tutti quei terreni bonificati di recente e quindi umidi per infiltrazioni sotterranee, più abbondanti in questo periodo delle piene dei fiumi.

(*b*) Semineremo in *gu* gli upland short staple precocissimi, che dovranno vegetare usufruendo della sola acqua di pioggia.

### *Irrigazioni.*

Per i cotoni egiziani credo sufficienti: una irrigazione (o l'acqua di pioggia) durante la semina, ed un'altra (o al massimo due) irrigazione circa 45 giorni dopo, l'inizio della fioritura. Una eccessiva quantità d'acqua produce al cotone un eccessivo sviluppo erbaceo, una grande caduta di capsule, un forte deterioramento della fibra; si prolunga il ciclo vegetativo della pianta, col rischio di avere il prodotto danneggiato dalle pioggie di *der*, e dai parassiti, che con la molta umidità facilmente si riproducono.

Eseguendo un buon lavoro preparatorio del terreno, e, successivamente, frequenti sarchiature, si salvaguarderà il cotone dai danni della siccità. I terreni della Somalia sono anche abbastanza compatti da trattenere l'umidità, che sarà ceduta poco per volta al cotone.

Ad Elvalda (Yubaland Italiano) in una località poco lontana dal fiume ed in *terreno profondamente lavorato*, fu eseguito il seguente esperimento:—

Il 24 novembre 1911 furano seminati circa mq. 500 di terreno, metà ad Abassi e metà ad Afifi.

Il 12 marzo 1912, il cotone, che si era mantenuto in ottime condizioni di vegetazione, era in completa maturazione, di modo che, dopo soli 108 giorni dalla semina si poterono raccogliere 35 Kg. di ottima fibra. In questo periodo di tempo non cadde un mm. di pioggia, ed il Giuba si mantenne sempre in magra. Nessun lavoro fu eseguito al terreno dopo la semina, nessuna cura fu prodigata al cotone.

Credo poter spiegare il buono stato vegetativo del cotone, che non ricevè pioggia o irrigazione, per il lavoro profondo fatto al terreno; e la grande precocità di maturazione per la scarsa quantità d'acqua che si trovò a disposizione della coltura.

I cotoni upland seminati durante le piene dei fiumi, potranno ricevere una irrigazione all'atto della semina ed un'altra, se sarà possibile, circa 40 giorni dopo.

## *Epoca della Raccolta.*

La raccolta dei cotoni egiziani avverrà in *der* e potrà forse il prodotto essere un po'danneggiato dalle piccole pioggie di novembre. Si cercherà quindi, per quanto sarà possibile, di anticipare ed affrettare la raccolta. I cotoni upland seminati in *gu* si raccoglieranno in *hagai*, quelli seminati in *der* saranno maturi in *gilal*, senza temere per questi i danni delle pioggie.

### *Coltura Annuale o Poliennale del Cotone.*

Anche i cotoni erbacei, in Somalia, possono assumere la fisonomia di pianta perenne, come i cotoni Caravonica.

E' conveniente quindi mantenere il cotone in coltura annuale, o poliennale?

Tanto per l'una coltura, quanto per l'altra, esistono vantaggi e svantaggi, non ancora esaurientemente ponderati.

Con la coltura poliennale si risparmiano tutti i lavori preparatori del terreno, di sistemazione della superficie per l'irrigazione e di semina; il cotone poi, approfondendo molto le radici, riuscirebbe meno sensibile ai danni della siccità prolungata.

Il prodotto della coltura poliennale sembra però che vada rapidamente deperendo dopo il primo o secondo raccolto; di più la pianta del cotone si trova costantemente donneggiata dai parassiti animali, che hanno agio di moltiplicarsi rapidamente, trovando pasto abbondante e clima favorevole.

Poco dopo aver potato fin quasi al colletto la pianta, che ha dato il prodotto, ed aver bruciato le ramaglie secche, nuovi rami spuntano e si apprestano a fiorificare, e fruttificare, e nuove generazioni di insetti assalgono vittoriosamente piante e prodotti.

Attendiamo che esperienze condotte su vasta scala possano presto fornire nuovi elementi di giudizio per questo importante problema.

## Considerazioni su Alcune Condizioni Dell'Ambiente Economico-agrario Sfavorevoli alla Coltura del Cotone in Somalia.

### *Mano d'Opera.*

È inutile farsi delle illusioni: in Somalia manca attualmente la mano d'opera necessaria per coltivare estese zone a cotone.

Giacchè le poco numerose popolazioni liberte, che sono dedite all'agricoltura, per il loro attaccamento alle sciambe, non potranno offrirci che scarsa mano d'opera di salariati: per essi converranno dei contratti a compartecipazione, come si usa in Eritrea ed altrove.

Le popolazioni di vera razza somala, più numerose delle precedenti, sono dedite alla pastorizia ed in questi ultimi anni soltanto hanno fornito ai coltivatori italiani un po'del loro lavoro, saltuario però e poco efficiente.

Anche potendo utilizzare nel miglior modo possibile e liberti e somali, la deficienza lamentata permane in tutta la sua gravità presente, non futura, giacchè in una qualsiasi località della Colonia oggi sarebbe quasi impossibile trovare la mano d'opera necessaria a coltivare appena 5,000 Ea. a cotone.

Nè possibile è dirigere per ora al Benadir parte della nostra emigrazione, perchè anche ammesso che i nostri lavoratori della terra possano laggiù acclimatarsi, non riuscirebbero a trovare quella forte remunerazione, che ottengono invece nelle Americhe e nella stessa Europa.

Ed il Governo Coloniale, quindi, oltrechè occuparsi di estesi esperimenti colturali in aziende di Stato, che i farmers somali non reclamano d'urgenza, e di tentativi di colonizzazione bianca, dovrà, per altre vie, cercare la risoluzione di questo urgentissimo problema, se ha a cuore che s'inizi l'utilizzazione agraria della Somalia, con una estesa coltivazione di cotone. Perchè gli industriali e capitalisti italiani, che cominciano ad interessarsi di nuovo del Benadir, naturalmente ricchissimo, pretendono a ragione siano rimosse dal Governo le difficoltà più gravi dell'ambiente economico, contro cui s'infrangerebbero tutti i loro sforzi e la loro buona volontà.

Si è scritto da molti di far venire o dalla Cina o dall'India o dall'Arabia o dall'Abissinia la mano d'opera mancante. Studi diligentemente il Governo queste ed altre proposte e venga a qualche pratico risultato. Forse coll'impiego su vasta scala delle macchine agricole, non escluse in seguito quelle che da tempo si sperimentano in America per la raccolta della fibra del cotone, si potrà attenuare un po'la gravità del problema.

## *Problema Idraulico.*

Lo accennerò soltanto fugacemente.

Le zone paludose o naturalmente irrigabili dalle piene dei fiumi non sono invero molto estese in Somalia, dove invece predominano le plaghe, che solo artificialmente possono ricevere l'acqua dai fiumi.

Il sollevamento meccanico con pompe centrifughe o altro, applicabile per limitate irrigazioni, si rende impossibile sia dal lato tecnico che da quello economico, per coltivazioni molto estese di cotone: per queste può convenire solo lo sbarramento dei fiumi, per ottenere un elevato livello delle acque, che permetta di potere avere l'acqua a basso prezzo, anche a grandi distanze.

Lo Scebeli, specialmente nel suo basso corso, non si presterà ad irrigare zone molto estese a causa della sua piccola portata in certe stagioni dell'anno.

Solo il Giuba, per la sua ricchezza di acque, potrà con opportuni barrages, irrigare facilmente le pianure feraci della Goscia (Yubaland Italiano). Poichè il talweg del corso del Giuba segna la linea di confine fra la Somalia nostra e la Colonia Inglese dell'Africa Orientale, qualunque lavoro sia per farsi sul fiume, dovrà eseguirsi d'accordo fra le due Potenze rivierasche. Ad una intesa Italo-Inglese devono appunto mirare gli sforzi del Governo, per eseguire sul Giuba tutti quei lavori necessari alla risoluzione del problema idraulico della Regione.

## *I Trasporti ed i Mezzi di Comunicazione Interno.*

I trasporti di ingenti quantità di merce non possono compiersi in Somalia altro che con cammelli. Ci si può fare un'idea della gravità di questo problema, pensando ad un produttore di cotone che abbia da trasportare per 100 Km. ad es: parecchie migliaia di balle di fibra.

I camions automobili, che fanno ora servizio in qualche località della Colonia, non potranno essere adibiti con tornaconto al trasporto di notevoli quantità di cotone.

Per pochi mesi dell'anno funziona sul Giuba un servizio irregolare di piccoli piroscafi fluviali, italiani ed inglesi, che lo risalgono fino a Bardera. Questi steamers però scaricano a Giumbo (o Gobwen) la merce, che dovrà per giungere al porto *inglese* di Kisimayo, essere inviata o per via di terra a schiena di cammello (sono oltre 15 Km. di difficilissimo cammino su terreno dunoso e roccioso) o per via d'acqua, passando per la foce del Giuba. Può risalire detta foce uno speciale steamer, soltanto 4 o 5 volte all'anno, nei periodi delle piene del fiume e di altissima marea.

I trasporti in Somalia sono dunque difficilissimi e costosi ed a ciò il Governo dovrà provvedere.

Per le esigenze dei futuri coltivatori di cotone, occorrerà che dal portodi Brava (quando questo sarà creato) partano due tronchi ferroviari: uno per il paese di Margherita (nella Goscia), per raccogliere tutti i prodotti dello Yubaland, ed uno correndo vicino allo Scebeli per il paese di Balad, ove dovrebbero affluire, per via fluviale possibilmente, tutti i prodotti della ricca regione del Medio Scebeli.

Riassumendo quindi: la coltura del cotone che prospera in Somalia per le sue condizioni propizie di clima e di terreno, non potrà trovare la remunerazione che le compete, fino a che il Governo Coloniale non avrà almeno cominciato a risolvere la deficienza della mano d'opera, il problema idraulico e quello dei trasporti.

## II° ALLEVAMENTO DEL BESTIAME IN SOMALIA.[7]

Nell'attesa che la grande impresa cotoniera si compia e mandi la fibra alle industrie nostre soggette al monopolio Nord-Americano, il capitale troverà utile impiego in Somalia iniziando, con estesi allevamenti di bestiame bovino ed ovino, la produzione industriale della carne.

Per iniziare l'utilizzazione zootecnica della Somalia, presento il programma da me ideato, nella sua massima semplicità: migliorare la pastorizia indigena, avviandola

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[7] Consultisi il Volume, di recente pubblicazione, *dello stesso Autore,* ove detto argomento è ampliamente trattato : " *L'Impresa zootecnica nella Somalia Italiana Meridionale,*" edito a cura del Governo della Somalia Italiana, con Prefazione del Conte Eugenio Faina, Senatore del Regno, Roma, F. lli Bocca Editori, 1913. Lire 5.

verso la produzione, anzichè del latte (che è ora la funzione economica più importante) degli animali da carne, che attualmente scarseggiano negli allevamenti somali; impiantare un certo numero di grandi aziende europee d'allevamento, per ottenere quella forte disponibilità di bestiame da macello, che renda possibile il funzionamento dell'industria impiantatasi in Somalia, incaricata della manipolazione, trasporto e smercio della carne stessa, congelata o refrigerata, per i nostri mercati o per quelli egiziani.

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Al Benadir, su circa 30,000 Kmq. di superficie, nel 1910, sembra esistessero: —

764 mila bovini.
305 ,, camelli.
216 ,, ovini.

La pastorizia è certamente la maggiore ricchezza naturale della regione, la cui popolazione somala di pastori trae appunto dal bestiame e il nutrimento ed i talleri necessari ai suoi limitati bisogni. Il bestiame bovino specialmente, benchè allevato con metodi primitivi, trova nella ricchezza dei pascoli il nutrimento per prosperare e per fornire latte abbondante e carne saporosa. Per il miglioramento di queste razze indigene di bovini, non credo per ora indispensabile l'introduzione, su vasta scala, di riproduttori di razze perfezionate, i quali, necessitando di condizioni d'ambiente, che non può offrire ora la Colonia, non darebbero risultati soddisfacenti.

Per la creazione di aziende di allevamento utilizzeremo della Somalia tutte le località, che, per non essere suscettibili d'irrigazione, non potranno coltivarsi a cotone o ad altre piante; quindi tutte le immense praterie e boscaglie un po'lontane dai fiumi, ove potrà l'allevatore trovare nel sottosuolo con facilità l'acqua necessaria per l'abbeverata.

Le malattie del bestiame più gravi: la peste bovina e le tripanosomiasi, potranno essere vittoriosamente combattute: la prima praticando agli animali vaccinazioni antipestose, le seconde facendo evitare al bestiame le zone paludose, infette da tse-tse, che sono in Somalia poco estese e ben caratterizzate.

Il terreno sarà inoltre dato in concessione per un lungo periodo di tempo, gli animali riproduttori, con cui iniziare l'allevamento, potranno acquistarsi con poca spesa dagli indigeni, ed il bestiame somalo, abituato a prosperare pur nelle ingrate condizioni d'ambiente, potrà, con la selezione accurata e con un allevamento razionale, offrire una migliore utilizzazione delle sue funzioni economiche. L'allevatore non troverà in Somalia alcuna grave difficoltà dell'ambiente economico-agrario, perchè, mentre scarsa laggiù è la mano d'opera dei coltivatori, facile e ricca è quella dei pastori ed atta ai servizi zootecnici; non esisteranno per lui nè un problema idraulico, nè una questione dei trasporti nell'interno della regione.

Si dovranno impiantare al Benadir aziende zootecniche di grande ampiezza e di tipo pastorale estensivo:[8] l'allevatore sfrutterà le risorse agrarie spontanee dell'azienda a vantaggio degli animali, che in questa vivono in allevamento sempre brado, nè ci farà bisogno per ora di coltivare foraggi d'alto valore nutritivo, che le zone destinate ora al pascolo non potrebbero neppure produrre.

Poi, quando le condizioni zootecniche della regione saranno migliorate, anche l'ordinamento dell'azienda si differenzierà verso un sistema più intensivo, come appunto è accaduto nelle regioni di grande allevamento, in Argentina ed in Australia.

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Ma anche per questa utilizzazione zootecnica occorrono programmi precisi, uomini capaci e di buona volontà, capitali sufficienti all'impresa. Il Governo Coloniale dovrà in tutti i modi aiutare queste prime iniziative private, dovrà sostituire il vigente regolamento per le concessioni di pascolo con provvedimenti legislativi che tutelino meglio i diritti del concessionario, dovrà facilitare la scelta del terreno e l'acquisto delle fattrici bovine ed ovine ai coloni, e metterli in grado di difendere il bestiame allevato dall'infierire delle epidemie.

Con queste garanzie, in pochi anni il capitale troverà laggiù certa e forte remunerazione e la Somalia i primi successi dell'iniziativa italiana.

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[8] Vedi dettagliate considerazioni in merito, nella pubblicazione c.s. dello stesso Autore, pagg. 165-171.

# ALCUNI ASPETTI DELLA COTONICOLTURA NELL'ERITREA.

Per il Dott. Guido Mangano.

La coltura del cotone sarà presto tra le più importanti colture della Colonia Eritrea, ma fino ad oggi non ha potuto molto diffondersi. Gli indigeni la praticano saltuariamente e sempre su estensioni molto limitate e da qualche tempo, per gli alti prezzi della *dura*, l'hanno quasi abbandonata, pronti del resto a riprenderla non appena cessi la crisi attuale del cereale. Oltre che dagli indigeni la cotonicoltura é esercitata da una Società italiana in aziende situate in varie parti della Colonia, Società che provvede anche all'acquisto, allo sgranaggio e all'esportazione della produzione indigena e alla quale l'Eritrea deve in gran parte il suo movimento cotoniero.

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Nell'Eritrea la possibilità di coltivare il cotone é quasi dappertutto strettamente connessa, oltreché con il regime delle pioggie, le quali sono ovunque più o meno scarse, anche con la disponibilità di acque di irrigazione. E poiché queste derivano dalle pioggie cadute impetuosamente in un bacino che, per un complesso di ragioni che qui non é il caso di ricordare, non può trattenerle, ma deve lasciarle scorrere altrettanto rapidamente a valle, e poiché il periodo di pioggie é breve, raramente superante i 75 giorni, così le acque disponibili per la irrigazione si presentano in quantità notevoli, ma improvvise e impetuose e durante un periodo di tempo identico a quello delle pioggie che tali piene determinano. L'unica forma di irrigazione possibile é dunque oggi quella per inondamento, e tale si manterrà fino a quando, con opere grandiose, non si saranno creati dei bacini di raccolta dai quali derivare le acque nelle epoche e nelle quantità determinate dalle esigenze della coltura.

In alcune regioni della colonia però, e precisamente là dove il rilievo del terreno é tale da escludere la possibilità di inondamento, é tuttavia possibile la cotonicoltura e per la meno esigua precipitazione di pioggia e per la speciale natura dei terreni.

Possiamo così distinguere, dal punto di vista, essenziale per la coltura, della disponibilità di acqua di pioggia e di irrigazione, vari ambienti colturali, offrenti ciascuno una speciale forma di cotonicoltura. Astraendo dalla quantità di pioggia che cade annualmente e che per tutte le regioni é considerata assai scarsa, e non tenendo conto che dell'epoca in cui questa pioggia cade e di quella in cui l'acqua scorre nei fiumi, parmi si possano distinguere almeno tre diversi ambienti colturali e, di conseguenza, tre diversi tipi di cotonicoltura.

Vi sono infatti in Eritrea, sempre nelle regioni del bassopiano, delle zone a pioggie estive e a piene estive, delle altre zone a pioggie invernali e a piene estive ed invernali e infine delle zone a pioggie estive, ma non offrenti alcuna possibilità di irrigazione. Le zone a pioggie e a piene estive sono quelle del bassopiano e del mezzopiano occidentale. La coltura dovendo farsi sulle terre inondate, non potrà iniziarsi che dopo l'ultima piena, se il fiume non é idraulicamente sistemato, o dopo quel tale numero di piene che si ritiene sufficiente a dotare il terreno della quantità di acqua necessaria alla coltura, qualora il fiume sia regolato da opere che consentono di deviare le piene dal terreno coltivato. E poiché si ritiene, in genere, che il terreno debba essere molte volte inondato per immagazzinare sufficiente umidità, anche in questo secondo caso l'inizio della coltura coinciderà quasi con il termine della stagione delle pioggie. Da questo momento, cioé dal suo inizio, la coltura non avrà altro beneficio d'acqua fino alla stagione delle nebbie, fino cioé a dicembre-gennaio, nella quale epoca questa forma di precipitazione atmosferica sarà di qualche ausilio allo coltura, troppo lieve però per produrre degli effetti sensibili. Risulta perciò evidentissimo che anche in terreni bene inondati e di natura tale do conservare a lungo l'umidità immagazzinata, e trattati secondo le buone regole indicate per la conservazione dell'umidità stessa, dopo un certo numero di mesi di quasi assoluta aridità la coltura venga a trovarsi in condizioni disperate. Necessita quindi in tale ambiente di coltivare una varietà a ciclo breve, oltreché poco esigente in fatto di umidità, il cui periodo di fioritura si svolga del tutto prima che il terreno perda la sua freschezza.

La zona che abbiamo indicata per seconda, a pioggie invernali e a piene estive e invernali, é quella del bassopiano orientale i cui fiumi portano acqua non soltanto durante la stagione delle pioggie locali, che sono invernali, ma durante quella delle pioggie dell'altopiano, che sono estive.

Si comprende facilmente come, cæteris paribus, questa seconda zona offra, in confronto della prima, condizioni assai più favorevoli alla coltura, consentendo due successive coltivazioni, di cui la prima di una pianta a ciclo vegetativo assai breve, o la coltura di una varietà di cotone a lungo ciclo ed esigente in fatto di umidità, ma a prodotto assai più ricco che non le varietà adatte alle condizioni riferibili al caso precedente.

La terza zona, quella in cui le colture possono usufruire delle sole pioggie, presenta per ciò stesso condizioni assai meno favorevoli che le precedenti. Comprende la vasta regione del mezzopiano sud occidentale della Colonia e quelle parti del bassopiano verso il Gasc e Setit che non sono irrigabili. In questa zona due sono i tipi di coltura adottabili: uno che si avvicina, per la caratteristica principale che deve avere la varietà coltivata, a quella che è propria della prima zona, cioé coltura di varietà molto precoce avente termine quando il terreno ha esaurito la propria riserva di umidità, l'altro riducente la coltivazione da annua a perenne, per una durata di anni variabile, generalmente due o tre, allo scopo di avere al secondo anno piante pronte ad utilizzare le acque di pioggia e quindi capaci di fiorire e fruttificare abbondantemente finché il terreno é in buone condizioni di frescura. In tali condizioni di ambiente le due caratteristiche che deve possedere sopra ogni altra la varietà da coltivarsi, sono la precocità e la resistenza alla siccità.

Chiarita questa importante questione tecnica relativa alla forma da darsi alla cotonicoltura nelle varie regioni della Colonia, devesi considerare un'altra egualmente vitale e strettamente connessa alla prima, cioé la scelta della varietà da coltivarsi in ciascuna delle zone indicate: scelta che deve tenere conto, oltreché delle condizioni naturali del luogo anche di quelle relative all'ambiente economico in cui la coltura deve svolgersi e alle esigenze del mercato.

Attualmente la varietà più diffusamente coltivata in Colonia, indifferentemente nelle tre zone di cui s'é parlato, può considerarsi una varietà locale, perché già da vari anni introdotta in Colonia e necessariamente modificatasi dalla sua forma originaria. È' la varietà americana Allen's long staple, del gruppo Upland long staple, l'origine del quale non é perfettamente determinabile essendo esso il risultato di selezioni e di ibridazioni, in cui certo ebbe parte rilevante il *Gossypium hirsutum* e, secondaria, un'altra specie, probabilmente il *G. barbadense*. L'Allen l.s.é, tra i cotoni Upland più diffusi per lunghezza di fibra e per altre buone caratteristiche di questa, per la sua resistenza alle intemperie e per la sua discreta produttività. Ha però, nei luoghi d'origine, il difetto di essere tardivo, bene inteso rispetto ad altri Upland, di avere non poche esigenze rispetto alla qualità e alla freschezza del terreno e di dare un basso rendimento allo sgranaggio. Infatti il rapporto fibra-cotone intero é 27 : 100.

In Eritrea questa varietà importata dal Texas si é non poco modificata, come era logico attendersi, per lo sforzo notevole che la pianta ha dovuto sopportare nell'adattarsi al nuovo ambiente tanto diverso da quello originario. Fortunatamente però, nel complesso, le variazioni non sono state peggiorative, come invece spesso avviene, in quanto che mantenendosi le doti di produttività e di qualità della fibra, si poté constatare un aumento della resa allo sgranaggio. Devesi però notare che questo aumento si ebbe soltanto nelle zone del 1° e del 2° tipo, a terre inondate, mentre in quelle del 3° tipo si dové lamentare non soltanto che il rapporto fibra-cotone intero si é mantenuto inalterato, cioé basso, ma la qualità della fibra é peggiorata per diminuita lunghezza e finezza.

Oltre a questa varietà, che in seguito alle modificazioni subite, meritò di essere considerata come nuova e prese il nome di Carcabat, sono state e sono coltivate in Eritrea, ma su estensioni assai minori, altre varietà.

Prima ancora che fosse introdotta l'attuale varietà Carcabat, vennero esperimentate colture di cotoni egiziani, particolarmente delle varietà Mitafifi e Abassi. Oggi esse sono quasi del tutto scomparse dal territorio della Colonia, mentre oltre confine, nel Sudan, é la varietà Mitafifi quella più estesamente coltivata. Il loro abbandono fu quasi del tutto giustificato in quanto che gli esperimenti che ad esse si riferiscono furono per la massima parte eseguiti in quella zona del 1° tipo che, come ho già spiegato, richiede una varietà precoce e poco esigente in fatto di umidità.

Da tempo antico poi sono coltivate in Eritrea, dagli indigeni, delle varietà locali, non ben determinate, di cui la più diffusa é la varietà chiamata dagli indigeni *areb*, a seme non completamente vestito, a fibra corta (22 mm. circa) con basso rendimento allo sgranaggio (28 : 100) ma abbastanza fine e lucente.

Infine, a scopo sperimentale, sono state coltivate recentemente in Eritrea altre varietà di cotone: alcune indiane, altre americane di tipo Upland.

Di queste, oggetto di maggiore attenzione é stata la varietà King, o, per meglio dire, una delle molte varietà King, un Upland a corta fibra molto precoce, che nel suo paese d'origine é resistente alla siccità, molto produttiva ed a elevato rendimento allo sgranaggio.

Non é stato possibile conoscere i resultati veri delle prove colturali fatte dall'Ufficio Agrario dell'Eritrea particolarmente nel Seraé e nell'Acchelé Cusai, ma é certo che anche questa varietà americana avrà subito delle rapide modificazioni, che ritengo sarebbe molto istruttivo esaminare attentamente.

Ciò premesso, vediamo quali delle varietà oggi coltivate meritino di essere mantenute e quali possano essere introdotte con notevole probabilità di successo.

Nella prima zona, richiedente una varietà precoce e abbastanza resistente alla scarsezza di umidità, dobbiamo evidentemente escludere:

1° Le varietà egiziane più pregiate a lunga fibra, quali l'Abassi, il Mitafifi, lo Janovitch, il Sekellaridis, l'Assili, ecc., perché tardive e non resistenti affatto in un ambiente non ricco di umidità.

2° Le varietà egiziane meno pregiate, anche se sufficentemente adatte all'ambiente, perché a prodotto scarso e scadente.

3° Quelle varietà americane che essendo precoci e resistenti alla siccità, in grado maggiore che non sia richiesto all'ambiente della prima zona, dànno un prodotto di qualità scadente.

4° La varietà indiane, italiane ed eritree per il motivo indicato al capo precedente.

5° Tutte le varietà cosiddette arboree, le quali non dànno prodotto apprezzabile nell'anno di semina.

Stabilita a priori l'esclusione di queste varietà non resta che a scegliere tra quelle che ad una discreta precocità e resistenza ad ambiente non ricco di umidità uniscano una elevata produttività e una pregiata qualità di fibra: Caratteristiche queste possedute in grado abbastanza elevato dai cotoni americani Upland long staple e facilmente accrescibili mediante i procedimenti selettivi di cui parlerò più avanti.

È' da considerarsi quindi felicissima per questa zona, la scelta fatta dalla "Società per la Coltivazione del Cotone in Eritrea" della varietà sopra descritta e che oggi va sotto il nome di Carcabat, non perché questa varietà sia capace di dare *oggi*, in un ambiente come quello della 1a zona, il massimo risultato desiderabile, ma perché essa costituisce a mio parere il miglior punto di partenza per la creazione della varietà ottima per questo ambiente.

Nella seconda zona, che presenta di fronte alla prima il notevolissimo vantaggio di due stagioni di piene, con una stagione di pioggie coincidente con la seconda stagione di piene, esclusa la possibilità di fare due successive colture di cotone (come invece possono farsi di una pianta a ciclo vegetativo più breve che non quello del cotone anche più precoce) devesi coltivare una varietà che utilizzi nel modo più completo tutta la non indifferente quantità d'acqua che le pioggie e una buona sistemazione idraulica possono fornire alle coltivazioni.

Debbono però escludersi:

1° Tutte le varietà a breve ciclo vegetativo la cui maturazione verrebbe a coincidere con le pioggie e le seconde piene; 2° tutte le varietà a lungo ciclo, ma a prodotto eccessivamente scarso e scadente; 3° tutte le varietà cosiddette arboree che non dànno prodotto abbondante nell'anno di semina.

Fatta questa eliminazione é facile convincersi che la varietà adatta deve ricercarsi fra quelle egiziane a lungo ciclo, a fibra pregiata e a produzione abbastanza elevata. Evidentemente devesi ricercare in questa varietà un certo grado di relativa rusticità, data la non perfetta regolarità degli inondamenti e delle pioggie e dato il frequente spirare di venti forti. Credo quindi che la varietà riunente in sè tutte queste qualità sia la varietà Mitafifi, la sola che in condizioni di ambiente analoghe, per es. nel distretto cotonifero sudanese di Tocar, sia da tempo coltivata con successo. Naturalmente anche in questo caso vale l'osservazione fatta precedentemente, che cioé la varietà Mitafifi non può oggi dirsi la varietà ideale per l'ambiente della seconda zona, bensì la varietà dalla quale meglio si possa partire nell'opera di creazione di una varietà locale ottima.

Per la terza zona occorre una varietà molto più precoce e rustica che non quelle prescelte per la prima e la seconda zona: devesi cioé ricercare fra quelle varietà che, producendo fibra non del tutto scadente, siano a ciclo brevissimo e molto resistenti ad ambiente asciutto. L'esame quindi deve essere limitato alle varietà locali, a quelle americane precoci e a quelle indiane, escludendo non soltanto le varietà egiziane, ma anche quelle americane a fibra lunga. Una indicazione precisa di questa incompatibilità, almeno inizialmente, tra le condizioni di ambiente e le esigenze delle varietà a lunga fibra, la si é avuta nelle coltivazioni di questo 3° tipo fatte sul Gasc e oltre confine, le quali presentano una sensibilissima riduzione nella lunghezza della fibra ottenuta in confronto di quella del prodotto avutosi dallo stesso seme nelle colture del 1° e del 2° tipo.

Io ritengo che forse taluna delle varietà locali, oggi ben poco ancora conosciute, potrebbe essere utilmente migliorata fino a raggiungere un tipo soddisfacente. Ma mancandomi le basi per formulare un tale giudizio, considero che tale possibilità non vi sia e si debba quindi, come nelle altre due zone, procedere all'introduzione di varietà esotica. Non ho molta fiducia sulle varietà derivante da una larga ed apprezzata cotonicoltura, il mantenimento dell'unicità del tipo nei diversi distretti cotoniferi e nelle diverse forme di coltura, tanto che l'autorità non si perita di limitare la libertà dei privati imponendo loro di escludere dalle proprie colture tutte le varietà che non siano quella determinata dal Governo. Il sistema non é applicato dovunque, per motivi che non serve qui di esaminare, né sempre con giusti criteri, ma se ne riconosce tutta l'importanza e tutto il valore.

Tutto ciò nei riguardi dell'industria consumatrice e del buon apprezzamento della materia prima sui mercati di vendita. Ma vi sono altri vantaggi nell'unicità del tipo e questi riguardano più direttamente la produzione.

Ho detto che qualsiasi cotone, particolarmente quando introdotto in un paese nuovo, varia in maniera molto spiccata e che tali variazioni si prestano ad un'azione miglioratrice efficacissima da parte del coltivatore. Al tempo stesso però queste variazioni possono avvenire in senso peggiorativo, appena quando l'assistenza del coltivatore venga a farsi meno attiva e si presentino prossime e frequenti le cause di variazione non volute dal coltivatore stesso.

E' evidente che queste cause di non desiderata variazione, le quali hanno per di più il dannosissimo effetto di rendere inomogenee anche le singole partite dei singoli produttori, consistono nella promiscua coltura di varietà differenti o di una stessa varietà con sistemi colturali diversi. E ciò non soltanto per i pericoli di ibridazione naturale, più difficile a verificarsi di quanto generalmente si creda, ma per la facilità con cui o nel campo, o nel magazzino o nello stabilimento di sgranaggio, possono avvenire mescolanze di semi che dànno poi luogo a coltivazioni eterogenee nelle quali difficile e povera di risultati si eserciterà l'opera miglioratrice del coltivatore.

Inoltre, quando in una regione non si ottenga che un dato tipo di prodotto, l'industria dello sgranaggio é resa più semplice e più razionale: non più la necessità di impianti differenti con macchine sgranatrici adatte a ciascuno dei tipi sottoposti a lavorazione, né l'adattamento dannoso di un solo tipo di macchine alle differenti esigenze dei vari tipi di cotone lavorato.

Infine la maggior semplicità e la maggiore efficacia dell'opera sperimentale, di assistenza, e di consulenza esercitata dal Governo o dagli enti privati interessati al miglioramento della produzione.

Taluno potrebbe obiettare che, anche ammessi come indiscutibili i vantaggi dell'unicità di tipo, e considerata come imposta dall'ambiente l'adozione di una determinata forma colturale, non é prudente limitare la coltura ad una sola varietà, onde non escludere la possibilità che più lunghe esperienze indichino altra varietà come migliore di quella oggi prescelta. Mi pare giustificato rispondere che gli elementi di cui oggi disponiamo sono tali da renderci sicuri quasi sempre della giusta scelta di una data varietà come suscettibile dei più notevoli miglioramenti sotto la mano abile del selettore. E anche ammesso che il punto da cui oggi si parte non sia esattamente il migliore, assai difficilmente converrà in avvenire, dopo ottenuti dei perfezionamenti sensibili, il ritornare da capo e riprendere fin dall'inizio tutto il complesso lavoro di miglioramento. Nei casi invece nei quali la varietà migliore é oggi troppo difficilmente determinabile, come per noi nel caso delle terza zona eritrea, allora é giuoco forza rimandare la scelta a quando l'esperimentazione avrà detto la sua autorevole parola.

Concludendo su questo argomento dirò che io ritengo vitale per la cotonicoltura eritrea che i tre distretti cotoniferi in cui la colonia va divisa debbano complessivamente dar luogo a non più di tre tipi di prodotto, ai quali riescirà tanto più agevole il conquistare stabilmente un buon mercato, quanto più costanti nel tempo essi saranno. Necessario quindi che l'opera dei privati e più ancora quella del Governo siano intese ad ottenere nel più breve tempo questo risultato.

Il mezzo, o per meglio dire i mezzi, mi sembrano facilmente indicabili e non difficilmente applicabili.

1° Il primo e più essenziale é l'esclusione assoluta da ciascuna zona di varietà diversa da quella prescelta.

2° Che un identico criterio guidi il miglioramento delle varietà, e, perché ciò sia possibile, che la selezione, unico mezzo atto allo scopo, sia eseguita non dai singoli coltivatori ma da un solo ente, possibilmente di governo, il derivante da una larga ed apprezzata cotonicoltura, il mantenimento dell'unicità del tipo nei diversi distretti cotoniferi e nelle diverse forme di coltura, tanto che l'autorità non si perita di limitare la libertà dei privati imponendo loro di escludere dalle proprie colture tutte le varietà che non siano quella determinata dal Governo. Il sistema non é applicato dovunque, per motivi che non serve qui di esaminare, né sempre con giusti criteri, ma se ne riconosce tutta l'importanza e tutto il valore.

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Inoltre, quando in una regione non si ottenga che un dato tipo di prodotto, l'industria dello sgranaggio é resa più semplice e più razionale: non più la necessità di impianti differenti con macchine sgranatrici adatte a ciascuno dei tipi sottoposti a lavorazione, né l'adattamento dannoso di un solo tipo di macchine alle differenti esigenze dei vari tipi di cotone lavorato.

Infine la maggior semplicità e la maggiore efficacia dell'opera sperimentale, di assistenza, e di consulenza esercitata dal Governo o dagli enti privati interessati al miglioramento della produzione.

Taluno potrebbe obiettare che, anche ammessi come indiscutibili i vantaggi dell'unicità di tipo, e considerata come imposta dall'ambiente l'adozione di una determinata forma colturale, non é prudente limitare la coltura ad una sola varietà, onde non escludere la possibilità che più lunghe esperienze indichino altra varietà come migliore di quella oggi prescelta. Mi pare giustificato rispondere che gli elementi di cui oggi disponiamo sono tali da renderci sicuri quasi sempre della giusta scelta di una data varietà come suscettibile dei più notevoli miglioramenti sotto la mano abile del selettore. E anche ammesso che il punto da cui oggi si parte non sia esattamente il migliore, assai difficilmente converrà in avvenire, dopo ottenuti dei perfezionamenti sensibili, il ritornare da capo e riprendere fin dall'inizio tutto il complesso lavoro di miglioramento. Nei casi invece nei quali la varietà migliore é oggi troppo difficilmente determinabile, come per noi nel caso delle terza zona eritrea, allora é giuoco forza rimandare la scelta a quando l'esperimentazione avrà detto la sua autorevole parola.

Concludendo su questo argomento dirò che io ritengo vitale per la cotonicoltura eritrea che i tre distretti cotoniferi in cui la colonia va divisa debbano complessivamente dar luogo a non più di tre tipi di prodotto, ai quali riescirà tanto più agevole il conquistare stabilmente un buon mercato, quanto più costanti nel tempo essi saranno. Necessario quindi che l'opera dei privati e più ancora quella del Governo siano intese ad ottenere nel più breve tempo questo risultato.

Il mezzo, o per meglio dire i mezzi, mi sembrano facilmente indicabili e non difficilmente applicabili.

1° Il primo e più essenziale é l'esclusione assoluta da ciascuna zona di varietà diversa da quella prescelta.

2° Che un identico criterio guidi il miglioramento delle varietà, e, perché ciò sia possibile, che la selezione, unico mezzo atto allo scopo, sia eseguita non dai singoli coltivatori ma da un solo ente, possibilmente di governo, il quale fornisca ai coltivatori il seme selezionato occorrente per le loro colture, seme proveniente da una o più stazioni apposite, nelle quali con unicità di intenti si vadano gradualmente ad ottenere e a fissare i caratteri che si desiderano e che la varietà é suscettibile di assumere.

Non é luogo qui che io indichi come dovrebbe organizzarsi tale importantissimo servizio di fornitura di seme selezionato, in modo da renderlo agile e perfettamente corrispondente allo scopo.

3° Poiché malgrado i provvedimenti di cui al nº 1 e 2, non sarebbe possibile avere in modo assoluto l'unicità del tipo in tutte le partite del prodotto ottenuto o per difettosa coltura, o per effetto di malattie o per non accurata raccolta o per non buona conservazione o per male eseguita separazione della fibra dal seme o per un qualsiasi altro motivo, parmi che a rendere impossibile che non accorti o non scrupolosi acquirenti mescolassero alle migliori le partite più scadenti, si dovrebbe istituire un servizio di classificazione delle partite, come si é ritenuto di dover fare nel Sudan Anglo Egiziano, classificazione che attribuisce a ciascuna balla di cotone una determinata classe, la quale viene indicata sulla balla stessa con un ben evidente contrassegno. Questa classificazione dovrebbe farsi prima sui mercati locali del cotone intero, onde evitare che diverse qualità vengano mescolate all'atto dello sgranaggio, e poi all'uscita delle balle di esportazione dallo stabilimento di sgranaggio e di pressatura.

Neppure di questa organizzazione é qui il caso di rattare con dettaglio: basti l'avervi accennato e l'aver detto che essa é assai meno complessa di quello che a prima vista potrebbe sembrare e tale da garantire validamente non solo gli interessi della Colonia ma quelli del commercio e dell'industria cotoniera.

Una quarta questione deve essere ora toccata, quella del posto che il cotone deve occupare nell'attività delle singole aziende. Se cioé nelle zone a cotonicoltura il cotone debba o possa essere la sola pianta coltivata o debba invece essere avvicendata con altre colture e con quali. È' evidente che le diverse condizioni ambientali offerte dalle tre zone da noi distinte, portano anche a questo riguardo a tre differenti casi.

Nella prima zona io non credo che l'avvicendamento colturale sia una necessità tecnica visto che le alluvioni dei fiumi depositano annualmente sul terreno una notevole quantità di limo che non é costituito di sola argilla, ma é ricco di sostanze di varia natura certo sufficienti a reintegrare quello che con la coltura annualmente perde il terreno che da identiche alluvioni é stato originato; e atteso che sono da considerarsi praticamente sufficienti ad allontanare il pericolo che gli agenti di malattie del cotone si propaghino da un anno all'altro, i mezzi adottati o che dovranno adottarsi severamente per la difesa e la lotta contro le malattie stesse.

Il far partecipare il cotone ad un avvicendamento con altre colture sarà probabilmente necessario, ma in tal caso sarà certo voluto da esigenzi di ordine economico che sarebbe troppo lungo indicare.

Neppure nella seconda zona l'avvicendamento sarà imposto da ragioni tecniche, ma solo da considerazioni d'ordine economico. Anche qui i terreni sono abbondantemente arricchiti periodicamente dal limo portato dalle acque di piena e anche qui vengono a mancare le forti ragioni per cui il ripetersi di una coltura é di solito irrazionale.

Ma economicamente é senza dubbio svantaggioso il sistema che instaura e mantiene un regime di monocoltura e quindi anche in questa seconda zona dovrà applicarsi un qualche avvicendamento colturale: nel determinare il quale, se si sarà favoriti dal fatto che in questa zona la doppia stagione di piene rende un po' più larga la scelta delle piante che possono venir coltivate, si dovrà anche ricordare che la varietà di cotone é in questo caso a lungo ciclo e tiene quindi occupato il terreno un tempo maggiore che non la varietà coltivata nella prima zona, e tale ad ogni modo da escludere la possibilità di praticare colture intermedie fra due successive di cotone. Credo quindi che la rotazione da prescegliersi, avendo a propria base la coltura del cotone, debba far posto ad altre colture annuali (non perenni, tranne che nei terreni non irrigui essendo l'irrigazione fatta per inondamento) a breve o a lungo ciclo, che consentano non soltanto la produzione di generi necessari sul posto o di facile mercato, ma offrano ai coltivatori occupazione il più possibile costante. Non è qui il caso di dilungarsi su tale sogetto, basti solo notare che il doppio periodo di piene può consentire nello stesso anno due successive colture di piante a breve ciclo, quali la dura, il bultuc, il sesamo, l'arachide e che anche in questa zona, come già nella prima, un grande ausilio potrà aversi, ad esempio, dalla coltura del *Cajanus indicus*, leguminosa che ha già dimostrato il suo completo adattamento alle condizioni del luogo e che è utilissima come fornitrice di foraggio e di materia da sovescio.

Nella zona a sole pioggie, che presenta evidentemente una non piccola varietà di terreni e che forse, dopo un più attento studio delle sue diverse parti, non potrà più essere considerata come un tutto solo, il fatto d'essere la coltura del cotone mantenuta più di un anno sul terreno rende l'avvicendamento ben diverso da quelli adottabili nella prima e nella seconda zona. Poiché in questa terza zona saranno coltivati in prevalenza terreni più o meno compatti, come più suscettibili di conservarsi, per qualche mese dopo le pioggie, in istato di sufficiente freschezza, io ritengo che ad es. la coltura dell'arachide, che per la prima e la seconda zona é indicabile per i terreni più sciolti, non possa trovar posto, e che invece il sesamo, oltre i cereali ed altre piante già usualmente, se non diffusamente, coltivate dagli indigeni del mezzopiano e del bassopiano sud occidentale, se intercalate di tempo in tempo con un riposo o aiutate da una qualche forma di concimazione, potranno dar luogo a una rotazione, se non teoricamente del tutto razionale, certo praticamente assai conveniente.

## LA COLTIVAZIONE DEL COTONE NELLA COLONIA ERITREA.

Per Gino Lavelli de Capitani.

Per avere un concetto di quanto si è fatto nella Colonia Eritrea in rapporto alla coltura cotonaria, è necessario analizzare l'opera della "Società per la Coltivazione del Cotone nella Colonia Eritrea" e ciò pel fatto che a questa Società, se non ufficialmente, certo in linea di fatto fu attribuito il compito di uno studio pratico di detta coltura, e per avere un concetto riassuntivo di questo lavoro che fu iniziato dieci anni or sono, crediamo opportuno svolgere i seguenti argomenti: —

(1) Risultanze tecniche e finanziarie dei primi tre anni di esperienze.

(2) Impianto industriale per lo sgranagio del cotone; lavorazione del seme ed industrie sussidiarie che si dimostrarono necessarie pel regolare andamento del lavoro.

(3) Risultanze tecniche e finanziarie dei successivi setti anni di coltura cotonaria.

(4) Programma per ottenere un intensivo sviluppo della coltura cotonaria e ciò coll'intervento diretto dell'Ente Governo.

### 1°.

Dobbiamo alla genialità del Governatore Ferdinando Martini, attuale Ministro delle Colonie, l'iniziativa di studi intorno alla coltura del cotone. Si ottennero allora dati dimostratisi all'atto pratico incerti, ma ebbero l'immenso pregio di richiamare sull'iniziativa l'attenzione degli industriali Italiani che decisero di fare un serio tentativo.

Questa è l'origine della "Società per la Coltivazione del Cotone nella Colonia Eritrea."

Il compito della Società fu quanto mai arduo. Gli studi iniziali fatti dal Governo. che pur formarono la base del programma d'azione sociale, come già osservammo, si addimostrarono subito insufficienti e l'impresa si trovò fin dall'inizio a lottare con grandi difficoltà, quali la scelta dei terreni, l'adattamento della mano d'opera, allora dedicata solo alla pastorizia, la ricerca della qualità di cotone più idonea in confronto al terreno ed al clima, lo studio del quesito industriale, l'impianto di tutta un organizzazione regolare in un'ambiente per natura diffidente, con insufficienti mezzi di trasporto, senza strade, senza il più elementare comfort della vita materiale per chi doveva dedicare tutta la propria energia creando dal nulla, lottando contro le febbri malariche ed un clima torrido.

Il primo anno in Agordat furono iniziati gli esperimenti colle qualità di seme Abassi e Mitafifi, si lottò contro l'invasione delle cavallette respingendole con molteplici fuochi accesi e grandi clamori du uomini, contro l'irruenza dei fiumi e dei torrenti che obbligarono alla risemina; si lottò contro la siccità che sopragiunta in alcune località dopo il periodo delle pioggie, arrestò la vegetazione intisichendo verdeggianti campi di cotone che promettevano abbondante raccolto. Questa lotta costò grave sacrificio ma si ottennero i primi 400 quintali di cotone che, mandato a sgranare in Egitto viene trovato di buona qualità come fibra e rendimento. Si ebbe di conseguenza la prima conferma dell'adattabilità del suolo coloniale alla coltura cotonaria; si constatò che a preferenza si deve appoggiarsi su qualità di cotone sempre a lunga fibra, ma con ciclo vegetativo tale che si svolga tra il cadere delle pioggie ed il periodo di tempo in cui il terreno mantiene l'umidità a pioggie finite. Questa è la prima tappa di una marcia faticosa. Oltre a ciò, viene studiato attentamente l'ambiente, facendosi un criterio esatto della situazione, cioè, l'impossibilità di svolgere sull'inizio una coltivazione estensiva diretta, mancando un piano razionale di bonifica il quale potesse rendere atte alla coltura cotonaria estese zone di terreno, e mancando altresi mano d'opera atta allo scopo.

Il quesito della mano d'opera richiese speciale studio. La popolazione Eritrea è un'amalgama di varie razze con religioni e costumi diversi. Essa è composta di Abissini.

Bileni, Beni-Amer, Baria, Basa. Il primo contatto con elementi così diversi non fu senza difficoltà e ciò per la naturale diffidenza dell'indigeno verso il bianco, ma il tasso della paga, una lira la giornata, fu buona leva per una popolazione che raramente vedeva la moneta nei suoi scambi fatti nel maggior dei casi col baratto di merci. Vinta la prima ripugnanza e trascinata questa gente al lavoro, si trovò di poter disporre di una popolazione intelligente e volonterosa, e con questo buon affidamento viene iniziato il secondo anno di lavoro.

Le qualità di cotone coltivate il primo anno, come abbiamo visto, lasciarono dei seri dubbi riguardo allo loro adattabilità all'ambiente, ma d'altra parte portare un cambiamento radicale alla qualità era partito arrischiato. Fu scartato, è vero l'Abassi, pianta troppo delicata e dal ciclo lunghissimo si rimase però fedeli al Mitafifi che aveva dato risultati più incorraggianti e su questo si basa la semina del secondo anno. Sempre però fermi nel concetto di trovare una qualità che corrispondesse all'esigenze del terreno e del clima, viene sottoposto a mezzo dell'Ambasciata di Washington, all'Ufficio Agrario degli Stati Uniti, il quesito onde avere una valida guida nel risolvere il difficile problema e Questo Ufficio indica una nuova qualità, prevedendo in modo preciso i buoni risultati ottenibili. Ammirevole percezione che fu poi sanzionata dai fatti, e per la quale si deve avere speciale gratitudine per quell'Istituto. In seguito a ciò venne adattato questo seme, sempre però su piccolissima estenzione di terreno.

Durante il secondo esercizio, la cerchia delle indagini viene allargata allo scopo di cercare nuove zone atte alla coltura cotonaria. Si inizia pure la coltivazione del cotone fatta direttamente dall'indigeno sotto la sorveglianza della Società e mediante anticipi in seme e denaro, coll'impegno da parte della Società di acquistare il prodotto ottenuto alle condizioni stabilite dal Governo Coloniale.

Il terzo anno fu davvero confortante: la nuova qualità che aveva dato buoni risultati nella precedente stagione applicata su maggiore scala, dà un raccolto considerevole in rapporto all'estenzione di terreno coltivato, circa

1,100 quintali, e fa quindi triplicare la media unitaria del raccolto; mentre il Mitafifi presenta le solite caratteristiche, pianta fiorente, promessa di raccolto straordinario, ma ad un dato momento tutto rinsecchisce. All'indigeno però non si arrischia a dare subito questa nuova qualità, che poteva presentare delle sorprese, e se il nativo portò 1,700 quintali in luogo do 300 del primo anno, lo si deve all'aumentata superficie coltivata.

Riassumendo, nei primi tre anni si sono ottenuti non indifferenti risultati tecnici, quali; dimostrazione pratica che varie zone della Colonia Eritrea, sono atte alla coltura cotonaria; la specificazione della qualità di seme più confacente, la bontà industriale del prodotto ottenuto e l'inizio della coltura fatta a mezzo degli indigeni.

Dal lato finanziario la Società ha dovuto sopportare una perdita che si aggirò intorno alle L.150,000 ma certamente questa non può essere considerata eccessiva, in confronto del grave problema che si andava studiando e fu questa considerazione che spinse a continuare lo studio sempre con maggior intensità ed energia.

2°.

Il progressivo svilupparsi della produzione cotonaria, ha imposto la sistemazione industriale dell'Azienda coloniale, ed al primo piccolissimo impianto di sgranaggio fu sostituito un'impianto completo in tutte le sue parti e ciò fu dal terzo al quarto esercizio.

La massima difficoltà superata fu quella del trasporto avendo dovuto per circa 200 km. portare il pesantissimo macchinario per regioni senza strade ed a forti dislivelli. Si è pure dovuto trovare sul luogo materiale costruttivo, fabbricando direttamente calce e mattoni ed utilizzando come legname di costruzione quello proveniente dalla palma Dum fino allora non ritenuto idoneo a questo scopo.

Perchè l'impianto industriale potesse regolarmente marciare si è dovuto dedicare circa un anno per l'avviamento e questo tempo non deve essere considerato eccessivo se si tengono presenti le molteplici difficoltà superate.

L'impianto consiste in una caldaia a vapore della potenza HP 120 con motore di eguale potenza che aziona una centrale elettrica la quale a sua volta distribuisce la forza a tutti i vari riparti.

Un fabbricato assai vasto è adibito a sala di sgranaggio con Roller Gins, pressatura e confezione balle cotone. Il seme, che a mezzo di varie coclee vien portato in una specie di piccolo silos, messo in vagoncini, vien portato in un speciale locale adibito per uso Oleificio. Qui il seme, prima viene passato alla Saw Gin per togliere il Linters, poscia passa al decorticatore che divide la parte oleosa del seme, dalla buccia; un crivello ne fa la selezione e la buccia viene utilizzata come combustibile, mentre che il seme va nei cilindri e quanè ridotto in farina, passa per un riscaldatore, quindi al former ed alla pressa. Il pannello per ora non ha ancora speciali applicazioni e nella massima parte si usa come combustibile; l'olio passa alla sezione di depurazione dove per mezzo di vassche, filtri e presse viene depurato e messo in condizioni di essere venduto come Summer Oil.

La lavorazione del seme fu trovata necessaria perchè causa le forti spese di trasporto, si era nell'impossibilità di venderlo sul mercato europeo, mentre che il mercato locale non poteva smaltire che la piccola parte utilizzata come seme. L'olio prodotto fu bene accolto in Colonia ed oggi si è costituita sul mercato una specie di marca assai riputata.

Per facilitare il grave quesito della mano d'opera, si è dovuto provvedere ad un impianto di macinazione della farina e ciò nei vari centri dove la coltura è maggiormente sviluppata; così fu messo un mulino a due macine in Agordat ed a Massaua ed una macina in Carcabat.

Lo studio del combustibile ha pure trascinato all'organizzazione di un'altra industria. Non potendo calcolare sul carbone che, data la distanza, assumeva un valore favoloso e non disponendo di boschi sufficientemente vasti che fornissero combustibili senza procedere alla distruzione dei boschi stessi severamente vietata dal Governo, si usufruì come combustibile il frutto della palma Dum, ma questa trovò subito utile applicazione nell'industria dei bottoni e non volendo distruggere un valore considerevole, fu attivato il commercio di queste noci sgusciate ed anche ridotte in fette e fu utilizzato come combustile lo scarto del nocciolo dum che assieme alla buccia di seme e parte di pannello non ancora utilizzato, formano il combustibile necessario pel regolare funzionamento della forza motrice necessaria agli impianti sociali.

Nei vari impianti sopra enumerati, furono immobilizzate circa L.600,000 ed essi nel loro insieme, costituiscono un impianto coloniale tipico.

Fu certamente speciale benemerenza della Società quella d'aver potuto formare una manualanza industriale perfettamente indigena, cosicchè negli opifici sociali, all'infuoridei capi officina che sono bianchi, tutto il rimanente personale è indigeno ed esso accudisce alle più delicate mansioni necessarie per il perfetto funzionamento del macchinario.

3°.

Sarebbe troppo lungo analizzare partitamente tutto lo svolgersi del lavoro fatto dalla Società dal terzo al decimo anno, ci limiteremo ad accennare i punti di maggior interesse.

Avuta la sicurezza riguardo la bontà del seme impiegato e l'adattabilità del terreno alla coltura cotonaria, emerse la necessità di abbandonare il carattere sperimentale, per dedicarsi allo sviluppo di quelle zone che furono trovate idonee e qui si è presentato in tutta la sua importanza il grave problema della sistemazione idraulica in modo che le acque dei fiumi potessero venire trattenute sul terreno nella quantità necessaria per garantire l'andamento regolare della coltura dalla semina, al raccolto.

L'esperienza aveva dimostrato che se per piccoli appezzamenti l'utilizzazione degli allagamenti non presentava speciale difficoltà, quando si è dovuto aumentare la superficie da porsi a coltura e conseguentemente il terreno fu preparato, pulito da ogni genere di vegetazione, le acque non trattenute da nessun ostacolo a poco a poco si formarono un letto scorrente al dissotto del livello normale, lasciando nella più assoluta siccità i terreni circostanti. Da qui emerse la necessità di una razionale sistemazione idraulica e quindi lo studio della portata dei fiumi e conseguente resistenza degli sbarramenti.

Questo studio fu il più gravoso e cui la Società dovette sottostare e ciò a causa di molteplici lavori idraulici dovuti fare per stabilire l'esatta portata delle piene e la resistenza degli sbarramenti, opera più di Governo che di Società privata. Il risultato di questi studi fu sottoposto all'esame del Governo Coloniale spingendolo ad assumersi la sistemazione definitiva delle varie zone della Società dimostrate atte alla coltura cotonaria.

Lo sviluppo della coltura cotonaria è più che mai legata alle sistemazioni idrauliche, perchè l'indigeno a malincuore dedica, ad una coltivazione per lui nuova, i terreni naturalmente allagati, che per abitudine e necessità vengono riservati alla coltivazione della dura e del Bultuc e cambiandone la destinazione si diminuisce la produzione e si aumenta il costo dei generi di prima necessità; se a questa tendenza si aggiungono alcune annate sfavorevoli per siccità o cavallette, si capisce come si sia venuto formando presso l'indigeno uno stato d'animo tale che gli fa considerare il dedicarsi alla coltura cotonaria cosa per lui dannosa ed oppone una sorda ostilità allo sviluppo di questa coltura. Da ciò la necessità da parte del Governo di bonificare terreni nuovi per fronteggiare l'impressionante diminuzione della coltura cotonaria riscontrato nei due ultimi anni e preparare la base di un forte sviluppo successivo.

La Società in seguito a ponderato studio è venuta introducendo nei rapporti suoi cogli indigeni un contratto di lavoro a colonia basato sul principio di dare all'indigeno la terra bonificata, garantir gli un determinato numero di giornate di lavoro a prezzo stabilito in modo che con queste provento l'indigeno possa far fronte alla spesa per la farina fornita dalla Società e per lui necessaria pel sostentamento della famiglia.

La Società fornisce pure gratuitamente l'acqua, garantisce l'acquisto del raccolto a condizioni precedentemente stabilite d'accordo col Governo; per contro la Società, quale compenso per l'organizzazione del lavoro, percepisce dall'indigeno un quarto del raccolto.

Questo sistema applicato già da due anni, ha dato buoni risultati, permettendo all'indigeno di procurarsi un equo guadagno quando circostanze speciali climateriche non decimino o distruggano il raccolto; per contro la Società elimina ogni rischio colturale o per lo meno nel caso più disgraziato limita la perdita all'ammontare della farina anticipata durante l'anno e nel caso favorevole, potendo disporre del quarto del raccolto, è in condizione di far fronte alle spese di organizzazione ed anche assicurarsi un discreto utile.

Questo tenace lavoro di esperienze e di indagini richiese alla Società sette anni di indefessa applicazione e se le risultanze finanziarie furono per lei veramente onerose, essa però ha portato il problema della coltura cotonaria al punto di poter essere convenientemente sviluppato dal Governo della Colonia Eritrea senza eccessivi rischi e con vantaggio della Colonia stessa. In una relazione particolareggiata la Società espose al Governo i risultati ottenuti e prospettò un programma di lavoro da svolgersi, ed il Ministero delle Colonie assieme al Governo dell'Eritrea, accettando le conclusioni proposte dalla Società, mercé l'autorevole interessamente di S.E. Il Governatore Marchese Salvago Raggi, hanno formulato un programma che in parte fu già approvato dal Parlamento ed in parte lo sarà tra breve.

4°.

I provvedimenti necessari per lo sviluppo della coltura cotonaria si riassumono come segue: —

Progressiva sistemazione idraulica delle zone dimostrate atte alla coltura cotonaria.

Sistemazione dei trasporti fra Agordat e Massaua-Sistemazione del porto di Massaua e delle linee di navigazione perchè l'inoltro della merce sia sollecito e poco costoso.

Per l'effettuazione dei lavori idraulici il Governo Coloniale ha stabilito una cifra annuale di circa mezzo milione per un periodo di dieci anni e con questa somma intrapprende la bonifica successiva delle zone dalla Società segnate come atte alla coltura, dedicando a ciascuna di esse a seconda del caso 200 e 300 mila lire ottenendo così dei centri di 2,000/3,000 ea. ciascuno.

Fu preferito il sistema di piccole bonifiche in considerazione della difficoltà di grossi concentramenti di mano d'opera cercando così di destinare ogni bonifica alle singole tribù, del luogo perchè possano con maggior facilità dedicarsi alle coltura. Mentre che se si dovessero fare delle sistemazioni di molte migliaia di ettari, ben difficilmente nel momento presente si potrebbe concentrare sufficiente mano d'opera, perchè questa si sposta difficilmente dalla zona ove essa abitualmente vive.

Il Governo farà pagare un canone che corrispondera all'interesse del denaro impiegato, più una percentuale per la manutenzione e l'ammortizzo e questa base si può ritenere equa quando il Governo garantisca che il terreno sia allagato sufficentemente per portare a buon fine il raccolto.

Il primo esperimento di questo genere fu fatto lungo il litorale della colonia valendosi delle torbide del fiume Falcat. Un'altro centro di coltura bonificato sarà Carcabat dove si svolsero gli esperimenti idraulici fatti dalla Società. Se questo programma sarà messo in esecuzione in modo continuativo e razionale, ben presto la coltura cotonaria della Colonia potrà dare un confortante risultato riguardo ai quantitativi; e la Colonia Eritrea potrà degnamente figurare nella lotta che tutti gli Stati Europei sostengono per svincolarsi dal mercato Americano.

Per le sistemazione dei trasporti, il Governo ha disposto in modo che la ferrovia sia prolungata fino al centro cotonario e questo programma per esser posto in effetto, necessita di qualche anno di lavoro e ciò perchè il primo tratto ferroviario si svolge in regioni montagnose che non permettono il sollecito proseguire del lavoro. Il giorno che da Agordat si potranno inviare al mare le varie merci a mezzo di ferrovia, potremo dire di avere superato una delle maggiori difficoltà, perchè i trasporti, come oggi sono effettuati, rappresentano una sensibile spesa e sopratutto hanno il carattere di eccezziole lentezza che rende assai lunga la smobilizzazione dei capitali. Mentre oggi dall'acquisto del cotone alla vendita, possiamo considerare un periodo di almeno tre mesi, colla ferrovia noi ridurremo questo periodo di tempo ad un terzo e ognuno si può immaginare con quale vantaggio. La sistemazione del porto di Massaua permetterà l'imbarco diretto da vagone a vapore, costituendo ciò una sensibilissima economia in confronto al sistema oggi usato.

Riassumendo: La Società, in dieci anni di lavoro ha potuto dare la prova dell'adattabilità delle terre Eritrea alla coltura cotonaria, ha studiato e trovato il seme adatto al terreno, il sistema di coltura, ha segnato la via da seguirsi nei rapporti tra industriale e coltivatore indigeno, infine ha ottenuto che il Governo dedicasse i capitali necessari perchè la coltura possa avere quello sviluppo che ognuno desidera e di cui la Colonia è suscettibile. I sacrifici dalla Società sopportati per raggiungere lo scopo prefisso, furono sensibilissimi se esaminati in confronto al capitale di cui disponeva, ma può con orgoglio ritenere di aver fatto opera veramente meritoria ed ora spetta al Governo ed ai cotonieri Italiani di dare impulso a questa iniziativa, perchè con sforzo collettivo si raggiunga quel tanto desiderato sviluppo della coltura cotonaria, che possa portare un sensibile aiuto alla industria Europea che vuol svincolarsi dall'egemonia Americana.

## THE COTTON INDUSTRY OF THE NORTHERN PROVINCES OF NIGERIA.

By P. H. Lamb.

*Director of Agriculture, Northern Provinces, Nigeria.*

Cotton has been widely grown in the Northern Provinces of Nigeria from time immemorial. When the earliest European travellers first visited the country they found the Hausas dressed in cotton clothes of their own making. Not only was cotton cultivation general, but spinning and weaving were then, as now, most important occupations of the people. Indigo was grown as a field crop, and dye pits were to be found in every village of any size. All this is still going on, in spite of the advent of the white man and the opening up of markets where cotton goods are offered for sale. The native in many cases still prefers his hard-wearing homespun to the more showy and cheaper, but less durable, Lancashire cloth. As, however, the manufacturer comes to study more closely the requirements of the people, this state of things will doubtless gradually alter.

The fact that cotton cultivation had been established for so long in Nigeria may lead many people to suppose that the conditions there must be admirably suited to cotton production on a large scale, and it has resulted in most extravagant statements being made to the effect that Nigeria could in the course of a few years supply the whole of Lancashire's requirements. Those responsible for such ideas, however, apparently entirely lost sight of the fact that the conditions necessary to enable the native to grow cotton in sufficient quantities to supply his own requirements were very different from those which would enable him to compete in the world's markets.

All that the Nigerian native wanted was to clothe himself and his family according to the custom of his tribe. He did not stop to consider whether the yield of his crop was large or small, or whether the staple was long or short, as compared with that of other countries. But when we come to consider the possibilities of Nigeria as a producer of cotton for the world's markets the aspect of things is entirely altered.

The only way by which the native can be induced to produce a crop for export is to create in him the desire for money. He will then strive to gratify that desire by the easiest method possible. In other words, he will do the work, or grow the crop, that will yield him the best return for his labour. That is the crucial test, and it is by this test that cotton must ultimately rise or fall in Nigeria. When viewed in this light, questions as to what is the yield per acre, what is the length and quality of the staple, and what is the ginning percentage, become all-important, for they determine what return the producer will get for his labour. It is the answer to this question which determines what shall be the leading crop or crops in every country, and it naturally results in a definite geographical distribution of the commercial products of the world into those countries best adapted for the production of each.

The rapid opening up of Nigeria to trade is resulting not only in a demand for cotton, but for ground nuts, cereals, and raw products of every description. There are in consequence many ways open to the native by which he may earn money, and the question as to whether cotton cultivation will be among the chief of them is just now being weighed in the balance. At present the tendency is to plant ground nuts in preference to cotton. The popularity of this valuable crop may be gauged by the fact that the export of ground nuts (mainly decorticated) has increased nearly tenfold in a single year. There is no doubt that the Northern Provinces of Nigeria as a whole are admirably adapted for the production of this oil seed, and that unless cotton cultivation can be made much more profitable than it is at present it will receive but scant attention.

The British Cotton Growing Association have for some years past spared no trouble or expense to develop the cotton-producing potentialities of the Northern Provinces of Nigeria. An account of the cotton industry of that country would therefore be incomplete without mention of the work which they have done and the results so far obtained. A uniform price of 1d. per lb. has been offered to the natives for all seed-cotton. Ginneries have been erected on the main transport routes for dealing with the crop, the lint being made up by means of hydraulic presses into 400 lb. bales, in which form it is shipped to Liverpool. Furthermore, large quantities of seed have been distributed annually through the Chiefs to the peasantry free of charge, so that nobody who desired to grow cotton should be prevented from doing so by lack of seed.

At present three power ginneries are maintained by the Association. One of these has been working since 1906 at Lokoja—the confluence of the Niger and Benue rivers—and last year shipped 339 bales. The other two plants are situated at Zaria and Ibi respectively, and were started in 1912. Their joint output for last year (1913) was 1,506 bales.

It will thus be seen that hitherto the output of cotton from the Northern Provinces has been quite small. It has, moreover, been derived purely from unimproved cottons of local origin. A brief survey will now be given of these indigenous cottons, and of the steps which have been taken by the Agricultural Department during the past year to improve the prospects of cotton cultivation.

The principal species in cultivation at the present time are the following:—

*Gossypium peruvianum*, two varieties.
,, *punctatum*.
,, *obtusifolium* var. *africana*.
,, *arboreum* var. *sanguinea*.

By far the most widely cultivated is *Gossypium peruvianum*, which develops into a strong-growing woody plant. The bolls are small, and the crop seldom seems to yield under native cultivation more than 250 lb. of seed-cotton per acre, but generally not as much. The length of staple is generally less than an inch.

The variety grown around Zaria is characterized by a dark red stem, this coloration extending to the leaf veins and in a lesser degree to the leaves themselves, reminding one forcibly of the American Upland variety, "Willet's red-leaf." The lint is cream-tinted, being in this respect like the Mitafifi of Egypt. The local variety of *Gossypium peruvianum* found in the locality of Ilorin has much the same habit of growth, but does not possess the peculiar coloration noted above; its lint, moreover, is not so deeply tinted, while its ginning percentage is only about 28, as against that of the Zaria variety, which works out on the average at 33.

*Gossypium punctatum*, which is regarded as being the wild form of *Gossypium hirsutum*, is found in general cultivation around Kano. Last year, on a trial plot of five acres, it yielded 268 lb. per acre, but as it gave only 25·37 per cent. of lint on ginning, it cannot be regarded as a profitable kind of cotton for the ginner to buy. The staple is about $\frac{7}{8}$ in. long.

*Gossypium obtusifolium* var. *africana* is grown as a perennial in the north, where the rainfall is too small and unreliable to support a more prolific variety. Its yield is small, the ginning percentage low, and the staple very short. These features render it quite unsuitable for export.

*Gossypium arboreum* var. *sanguinea* has nowhere been observed as a field crop, but a few plants may often be seen around compounds. It is used by the natives for the preparation of a medicine. Always grown as a perennial, it comes to maturity very slowly, and its yield appears to be very small, though the lint is long, strong, and silky.

Further particulars as to the botanical characteristics of the above species may be found in Watt's book on "The Wild and Cultivated Cotton Plants of the World."

Early in 1913 the recently formed Department of Agriculture decided to open experimental farms in two of the most promising centres for cotton cultivation, with the object of studying the native indigenous cotton of each district, and of testing its qualities against those of well-known and improved exotic varieties. The sites chosen for this work were situated in the Zaria and Ilorin Provinces respectively, the former representing the more arid conditions of the north, whereas the latter is situated some 200 miles further south, where the rainfall is heavier and the atmosphere more humid. A parallel series of variety tests was carried out at each of these places. The following table gives their respective rainfalls for 1913:—

| | Zaria. Measured on the farm. Inches | Ilorin. At Headquarters. Inches | Ilorin. On the farm. Inches |
|---|---|---|---|
| January | *Nil* | — | ...No available records |
| February | *Nil* | 0·03 | |
| March | *Nil* | 0·14 | |
| April | 0·75 | 4·58 | |
| May | 1·55 | 7·28 | |
| June | 3·11 | 4·75 | |
| July | 4·31 | 4·86 | |
| August | 10·13 | 10·96 | 13·87 |
| September | 7·10 | 8·57 | 11·30 |
| October | 0·95 | 2·65 | 4·83 |
| November | *Nil* | — | *Nil* |
| December | *Nil* | — | *Nil* |
| Total | 27·90 | 43·82 | |

The exotic varieties chosen for trial were Allen's Improved (Uganda seed), Nyasaland Upland (the acclimatized cotton of Nyasaland), and Durango (one of the latest improved American types). Ten acres of each of the imported varieties were grown at each farm, as well as five acres of the native local variety. The idea of having such large plots was to eliminate as far as possible field errors due to variations of soil, and at the same time to secure for propagation the following year appreciable quantities of any variety which should give promising results.

The Zaria farm was manured by the usual native method of kraaling cattle on the land at night. The amount of manure applied in this way was estimated at three tons per acre. No manure was applied to the Ilorin farm, as the land had not been cultivated for some years, and, moreover, no manure was available.

Two sowings took place—in June and July respectively—in order to minimize as far as possible risks occasioned by the weather.

The following table gives the comparative results:—

| | Zaria | | | | Ilorin | |
|---|---|---|---|---|---|---|
| Variety | Average yield of seed-cotton per acre | Ginning percentage | Selling price of seed-cotton | Gross return per acre | Average yield of seed-cotton per acre: On large plots | Average yield of seed-cotton per acre: On 1-acre plots |
| | lb. | | | £ s. d. | lb. | lb. |
| Allen ... ... | 391 | 29·83 | 1½d. | 2 8 11 | 63 | 61 |
| Nyasaland ... | 277 | 31·10 | 1⅜d. | 1 11 9 | 54 | 101 |
| Durango ... ... | 237 | 31·08 | 1⅜d. | 1 8 2 | 55 | 69 |
| Native {Zaria "Gwundi" Ilorin "Ishan"} | 284 | 30·97 | 1⅛d. | 1 6 8 | 63 | 121 |

It will be noticed that the yield at Zaria is greatly in excess of that at Ilorin, and this, in spite of the fact that, owing to scarcity of rain in the earlier part of the season, it was found impossible to cultivate the soil at Zaria more than 4 in. deep, whereas that at Ilorin was thoroughly prepared to a depth of 8 in. Nor can the difference be accounted for by irregularity of stand or stunted growth, since in both these respects the Ilorin farm compared very favourably with that at Zaria.

The cause of the almost complete failure of the Ilorin crop was boll-shedding. The same trouble was encountered, but to a less extent, at Zaria. Boll-shedding is, of course, a well-known phenomenon in every cotton-growing country, but on so wholesale a scale as occurred in the Ilorin Province last year it is absolutely disastrous. Excessive humidity or drought, and more especially marked alternations of these conditions, are its recognized causes. The last-named seems to have been mainly responsible at Zaria, where the rain often falls in very intermittent storms. At Ilorin, however, Mr. Thornton—who, before he joined the Department, had been engaged in cotton growing for some years in the West Indies—attributes this abnormal boll-shedding mainly to excess of rainfall and cloudy weather during the flowering season, when the plant requires copious sunshine with occasional gentle showers.

Referring to this subject, he says: "During the wet season there was a continual heavy shedding of buds and bolls, and the shedding of these increased after a day or days of greater humidity. Shedding decreased when the dry weather set in, and again increased shortly afterwards, but later decreased again after the plants had had a chance to accommodate themselves to the changed conditions.

"During the months of August and September, and early in October, when the buds were forming and flowering was taking place, the atmosphere was very damp and the sky almost continually cloudy."

Continuing, he says: "It might be suggested that it would be advisable to plant cotton at a time such that the formation of buds and flowers would take place after such unfavourable months were past.

"But then it must be remembered that directly after this wet period conditions change entirely round, and a drought sets in just as severe as it has previously been damp. And, as the soil is very porous, with little power of retaining moisture, there would be very little chance of the plants developing any size whatever to carry a crop. It is true that August this year was a very wet month, whereas it is usually a very dry one. This doubtless would affect the plants more than in a normal year, so that one cannot draw positive conclusions from one year's work."

In addition to the injury due to climatic causes, an immense amount of harm was done on the Ilorin farm by boll worm. It was proved that 200 per cent. of the bolls were wholly or partially destroyed by this insect. The worm most largely responsible for the damage was identified by the Imperial Bureau of Entomology as *Earias cupreoviridis*, and it was stated that this insect had not previously been reported as attacking the cotton boll. Efforts are being made by the Department to make the annual uprooting and burning of cotton plants compulsory in order to keep this and other insect pests in check. In a territory of such enormous size, however, where cotton has been cultivated by careless methods for generations, it is extremely difficult to enforce such a measure without legislation. Though such legislation would undoubtedly in the long run be in the interests of cotton cultivation, it is feared by some that it might for the time being cause a set-back in certain districts.

The natives of Ilorin seldom cultivate cotton by itself, but generally in conjunction with yams, the cotton being considered as of quite secondary importance. Our results in Ilorin this year certainly tend to justify this practice, as the yields so far observed are not large enough to warrant the amount of labour involved in treating it as a main crop.

At Zaria the results were much more positive, and though the yields are not large when compared with those of other countries, they must be regarded as a satisfactory beginning. The best acre of cotton on the farm yielded 627 lb. of seed-cotton. This plot was well manured, and was planted with Allen's Improved seed from Uganda. It was not part of the variety test.

Durango turned out to be the poorest of the exotic varieties, not only in yield, but also in strength of lint. It was chiefly remarkable for the immense size of its bolls.

The Allen's Improved and Nyasaland were both very satisfactory in the earlier pickings, but the later pickings were in every case weak. This weakness is almost certainly due to the fact that during the *harmattan*—a noxious wind which blows from the desert during the dry season—the plant dries up before it has time thoroughly to mature the bolls which set after the rains are finished, and consequently, though such bolls ultimately open, their lint consists in reality of dried immature fibres. The smallness of the yield of Nyasaland Upland as compared with Allen's Improved—277 lb. against 391 lb.—may largely be accounted for by the irregular germination of the Nyasaland seed, which resulted in an uneven stand of plants. It is anticipated that with locally grown seed this apparent shortcoming will disappear in the next crop. Several natives have already agreed to grow these two varieties in 1914 from seed raised on the Zaria farm in 1913, and we hope by this means to get 750 acres of long-staple cotton under cultivation this year. It is proposed to have the whole of the work carried out under native overseers, in order to minimize any possibility of this choice seed becoming mixed with native varieties. The whole of the resulting crop will be purchased at an enhanced price, warranted by the superior quality of the staple. The seed will thus become available for redistribution. Should these improved varieties continue to give satisfactory returns (which becomes increasingly likely as they become acclimatized the more perfectly to their new environment) their popularity will soon become so well established that they will ultimately replace the indigenous species.

All that can be expected of a Government cotton-seed farm is to introduce and test improved varieties. The subsequent propagation of the selected variety must always be done with the co-operation of a group of cultivators, the area cultivated extending annually from the centre as the supply of seed becomes available in larger quantities. This system has been proved again and again, not only in America, but more recently in India, Egypt, Uganda, and Nyasaland.

While thus endeavouring to improve the quality of the cotton of Nigeria as well as the yield per acre, the importance of reducing the cost of production by more up-to-date methods of cultivation is not being lost sight of. At present practically the whole of the arable land of Nigeria is turned over by hand; but on the Zaria farm last year a start was made in the use of implements by employing cultivators drawn by cattle to work the land under cotton. It is intended during the coming season greatly to extend this work, and if possible to induce natives to cultivate their own land by similar means, thus enabling them to employ their time to greater advantage than hitherto.

By this means alone the agricultural wealth of the community is capable of enormous expansion.

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# THE PRODUCTION OF FINE SEA ISLAND COTTON IN THE WEST INDIES, WITH PARTICULAR REFERENCE TO THE ST. VINCENT INDUSTRY.

By W. N. Sands, F.L.S.

*Agricultural Superintendent, St. Vincent.*

At least 130 years ago a fine cotton, presumably Sea Island, was grown in the West Indies, but according to Sir George Watt, in his book, "The Wild and Cultivated Cotton Plants of the World," p. 270, "There is little or no evidence in support of the belief that Sea Island cotton is indigenous to Barbados, nor in fact to any of the West Indian Islands," and he further states "that it is highly probable that the modern stock is a hybrid." Again on p. 272 he writes: "Although it is known that much intimacy existed between the early West Indian and American colonists, still the first direct mention of the conveyance of cotton seed from these islands to the mainland occurs in the year 1785. I have been told (though I have not been able to confirm the statement) that there is an older record regarding Charleston, in which mention is made of cotton being sent from the West Indies to America in 1714. It is recorded of 1785, however, that what appears to have been Sea Island cotton was first produced in Georgia from seed obtained from the Bahamas. In 1789 we next read of cotton seed, possibly Sea Island, having been sent from Jamaica to Georgia, but there seems to be some confusion, since it is at the same time spoken of as 'Pernambuco cotton.' This much, however, appears fairly certain—namely, that the cotton first exported from the United States went from Virginia and North Carolina, and was accordingly not likely to be anything but 'Levant' cotton—it certainly could not have been Sea Island—so that it is perhaps safe to infer that the United States of America obtained their stock of the Sea Island plant very possibly through the

West Indies, and that, too, so late as the middle of the eighteenth century.

"There would seem no doubt, however, that South America and the Antilles were growing a superior cotton closely akin to, if not identical with, much of the so-called Sea Island cotton of to-day, long anterior to its introduction into the United States."

At p. 278, *loc. cit.*, it is mentioned that many writers say that when the plant was first introduced into America it was a perennial, and that, through the accident of a mild winter and the selection of early maturing pods, combined with more advantageous methods of cultivation, a stock had been gradually matured with an annual habit directly adapted to the climatic conditions of a limited tract of country in the United States, and that this new and very special stock embraces all the finest grades and the most valuable cottons of the world, and is in fact true Sea Island.

The botanical name by which it is now known is *Gossypium barbadense* var. *maritima*, Watt.

The cultivation of long-stapled cotton in the British West Indies was never completely abandoned; it was revived during the American Civil War of 1861-65, but has been confined since then to a small production in the Grenadines of a coarse perennial type known as "Marie Galante." The best variety of this cotton still has staple of from 30 mm. to 35 mm. in length, although no special selection work has been done with it.

The revival of fine Sea Island cotton cultivation, however, dates from the year 1901, when small experimental plantings were made in St. Kitts, Antigua, Montserrat, and St. Lucia from seed obtained from the United States. In the two following years interest in this cotton rapidly increased in several of the smaller islands, and as the outlook appeared favourable, Sir Daniel Morris, then Imperial Commissioner of Agriculture for the West Indies, and Mr. J. R. Bovell, Superintendent of Agriculture, Barbados, paid a special visit to the Sea Island cotton districts of South Carolina and Georgia in September and October, 1903. The valuable first-hand information which these gentlemen obtained was of the greatest assistance to West Indian planters, for it enabled them to commence, without delay, the cultivation of the crop along the best lines. Besides, during his visit Sir Daniel Morris secured a large supply of seed of the best "Rivers" type produced on the seaboard of South Carolina. This type was first planted in 1904, and to-day is still largely grown. Other fine types were obtained from seed supplied by the British Cotton Growing Association and others, and these also have proved most valuable.

In the year 1905 the American growers of the finest types of Sea Island cotton, fearing West Indian competition, combined to prohibit the exportation of seed. It was at first feared that this action might make it difficult to maintain the quality of the cotton grown in the West Indies, but it was soon seen that with careful selection the quality could be readily maintained and in many instances improved, with the result that to-day the finest and strongest cotton in the world is produced in certain of these islands.

This, then, is a brief historical review of the fine Sea Island cotton industry of the West Indies.

The average annual output of British West Indian Sea Island cotton for the past three years is 2,352,755 lb., equal to 5,882 bales of 400 lb. each.

Last season, 1912-13, the quantity and value of the exports from each island were as follows:—

| | Weight lb. | Estimated value £ |
|---|---|---|
| St. Vincent | 443,878 | 35,141 |
| St. Kitts | 374,594 | 23,645 |
| Barbados | 424,392 | 23,223 |
| Montserrat | 292,182 | 18,478 |
| Antigua | 249,433 | 15,676 |
| Nevis | 166,477 | 10,513 |
| Anguilla | 112,138 | 7,009 |
| Jamaica | 59,606 | 3,571 |
| Virgin Islands | 31,775 | 2,095 |
| Total | 2,154,475 | £139,351 |

It will be seen that the chief British islands exporting Sea Island cotton are St. Vincent, St. Kitts, Barbados, and Montserrat. It might be mentioned here that this cotton is also cultivated to some extent in the foreign West Indian Islands.

St. Vincent, besides being the premier cotton-growing island, produces the most valuable cotton, but is closely followed by St. Kitts, where some exceptionally fine cotton is grown under somewhat similar conditions of soil and climate as those of St. Vincent.

It is proposed in this paper to refer more particularly to the St. Vincent industry for the following reasons: (*a*) The British Cotton Growing Association now strongly advise growers to cultivate for fineness of lint in view of the fact that certain Egyptian and American cottons are successfully competing with some of the Sea Island cotton produced in the West Indies, but not with that of St. Vincent; (*b*) the methods adopted in the production of cotton in the Colony and the measures taken for the protection of the industry have been under closer Governmental control than in any other island; and (*c*) the highest degree of success has been attained in the production of fine cotton.

In other islands a great deal of most valuable work has been done by the Agricultural Departments and planters under conditions often very unfavourable, and the results so far achieved bear striking testimony to the care and attention devoted to the crop, so that it must not be inferred from what has been stated above that it is only in St. Vincent that the industry is carried on to advantage and along the most approved lines.

The Island of St. Vincent is eighteen miles in length, with a greatest breadth of eleven miles, and a total estimated area of 150 square miles. A central backbone of mountains extends throughout its entire length with a large number of radiating valleys. The lands all slope from the mountains to the sea, and the drainage is good. Cotton can only be successfully grown on the lands at a fairly low elevation near the coast. The soil is of volcanic origin throughout, and may be classed as a dark, sandy loam. The subsoil is usually a compact tuff.

In St. Kitts the soils are also volcanic sandy loams; whilst those of the other Sea Island cotton growing islands are, as a rule, heavier in character, and range from loams to clay.

The rainfall of the cotton growing districts of St. Vincent is ample and often excessive, so that at all times the crop is a "gamble in rain."

The average total rainfall of the growing season—June to November—of the past three years in districts where cotton is extensively cultivated was as follows:—

| Month | Botanic Station | Agr. Exp. Station | Cane Grove | Peters Hope | Petit Bordel | Cumberland | Ratho Mill |
|---|---|---|---|---|---|---|---|
| June ... | 10·60 | 9·10 | 8·80 | 9·88 | 8·58 | 8·57 | 5·88 |
| July ... | 9·44 | 8·85 | 10·22 | 10·09 | 9·56 | 8·90 | 6·63 |
| August ... | 12·70 | 10·69 | 12·48 | 11·01 | 10·50 | 10·75 | 8·30 |
| September ... | 14·41 | 12·71 | 11·47 | 9·68 | 9·60 | 8·32 | 9·08 |
| October ... | 14·32 | 12·80 | 13·55 | 11·00 | 8·26 | 10·27 | 9·77 |
| November ... | 12·16 | 11·19 | 13·17 | 8·57 | 7·47 | 8·93 | 9·13 |
| Total inches | 73·63 | 65·34 | 69·69 | 60·83 | 53·97 | 55·74 | 48·79 |

If the totals be taken and an average struck, it is found that the mean monthly rainfall—June to November inclusive—ranges from 12·27 to 8·13 in. The rainfall of the other cotton-growing islands is much smaller than this.

Owing to the light soil and moist tropical climate the St. Vincent planter can produce a lint which, as mentioned above, commands the highest prices in the market, and enables him to obtain a remunerative return for his labour over an average of years. The area planted each season in the Colony amounts to about 4,500 acres.

Mention has already been made of the introduction of the "Rivers" and other fine types of seed from South Carolina, and it is from these that the successful local industry has been built up. Great care was necessary at the outset to ensure that only seed from the best grown fields of plants true to type was planted, and in the earlier years all this seed was selected, tested, and sterilized with corrosive sublimate (1 in 1,000) by the Agricultural Department before being sent out. This seed work is still carried on at the Government Central Cotton Ginnery and by planters, and only seed thus selected and dealt with is sown. The procedure adopted in preparing seed is as follows:—

The seed from special crop lots is first of all tested, and only that giving a germination of not less than 85 per cent. is retained. It is then de-linted to facilitate the work of selection, and spread out on tables covered with white cloth. Women who are specially trained in the work select the type showing the characters desired; that is, a heavy, sound black seed with a green tuft of fuzz at one or both ends. Seed that does not come up to this standard is rejected. The selected seed, as a rule, represents from 60 to 75 per cent. of the whole.

This may be termed the mechanical side of the seed work, but the scientific side is not lost sight of, and several planters besides the Agricultural Department carry on each season plant selection in nurseries so as to maintain and improve the quality of the lint and the yield of the crop. The methods of selection are based on desirable field characters of the plant, ginning yield of seed-cotton, and the length, fineness, strength, and lustre of the lint. Other work performed on a considerable scale by the Agricultural Department is the selection of plants showing resistance to certain bacterial and fungoid diseases.

To give a recent example of the value of this particular line of work, a planter in a wet district sowed last season 64 acres with seed of cotton with which no selection work had been done, and 2 acres with seed from plants selected as showing resistance to disease. From the 64 acres he obtained 8½ bales, or 3,060 lb. of lint, and from the 2 acres 1 bale, or 360 lb. of lint, or an average yield, under similar conditions, of 48 and 180 lb. per acre respectively. The price realized for the lint from the 64 acres was at the rate of 20d. per lb., and that from the 2 acres 22½d. per lb.

Arrangements are made with planters to grow special plots of cotton from seed obtained from selected plants at the Experiment Station, and at the present time it is possible to supply from the progeny of these specially selected plants all the seed necessary to meet the requirements of small growers, who, it might be mentioned, grow on an average about one-fourth of the island's output.

The work of maintaining the quality and yield of cotton has been greatly facilitated by the enacting of certain legislative measures. Under the Ordinance for the prevention of the introduction of pests and diseases, power is given the agricultural authority to destroy, fumigate, or sterilize all seed-cotton or cotton seed brought into the Colony, and the provisions of this valuable Ordinance have been and are strictly enforced. Under the "Agricultural Products Protection" Ordinance all sales of seed-cotton of a less amount than 100 lb. in weight at any one time have to be made to the Government Ginnery, but lots up to 4,000 lb. in weight can be purchased.

The primary object of this action was to prevent cotton stealing, but as the Government wisely purchases the cotton on a co-operative or profit-sharing basis, there are few sales to licensed dealers. There is now only one licensed dealer in the Colony, and the licence is held by a responsible firm, who in their own interest take care of the seed—the result is that the seed supply for planting is under close supervision. A third most valuable and important Ordinance is that which provides for the destruction of the old cotton stalks at the end of each season in order to prevent the carrying over from one season to another of certain pests and diseases. As the provisions of this measure cover all kinds of cotton, it has been possible to destroy all the perennial "native" varieties, and so reduce to a minimum the danger of cross-fertilization of the Sea Island variety with undesirable kinds. It is worth recording here that visitors to the island interested in tropical agriculture are often particularly struck with the uniformity of the cotton plants in the field and the absence of "rogues"—that is, plants not true to type. Under the Ordinance above named all kinds of cotton plants have to be pulled up and burnt by April 30 in each year, and in the Northern Grenadines a month earlier. Should an occupier of land neglect to destroy effectually all the cotton plants planted or growing upon land in his occupation by the stated time, the Cotton Inspector or other officer specially appointed can enter upon the land with the necessary labourers, perform the work, and recover the cost in the Small Debts Court; and further, the offender may be fined a sum not exceeding £10, or in default be imprisoned for any time not exceeding one month.

Sea Island cotton must, therefore, be grown as an annual crop in St. Vincent, but in all the other islands, except Barbados, it is cultivated as such, and it is probable that in this latter island also this practice will have to be followed if the industry is to survive, unless, of course, the leaf-blister mite (*Eriophyes gossypii*), which now occurs there, can be controlled, or a variety resistant to it raised.

The methods of preparing the land for planting vary in the different islands. The flat system is practised in Anguilla and very dry places generally; the ridge and the cross-hole systems are adopted in St. Kitts, Barbados, and Antigua; the ridge in St. Vincent and other places. Each has its advantages under the soil and climatic conditions peculiar to each place or district. The cross-hole system of St. Kitts allows of the land being easily planted in sugar-cane before the end of the cotton crop, cotton in this case being largely grown as an intermediate crop with cane. The ridge system is largely adopted in most of the islands, and is the only one practised in St. Vincent. This may be briefly described as follows: As soon as the rains come in and the land can be worked it is weeded, the grass, trash, manure, and green dressing material, if available, ranged off, and the land forked or ploughed. This latter operation is not always carried out, but when performed it ensures better cultivation. Ridges are then thrown up with the plough, fork, or hoe, and the manure and other materials completely covered. In cases where cotton follows cotton, the weedings and manure are ranged in the furrows and covered over by splitting asunder the old banks. These ridges are, as a rule, formed 5 ft. apart, but on poor land they are put closer together. A subsoil plough is sometimes run through the field previous to ridging to ensure deeper tillage. Only small quantities of chemical manures are used, and experiments made so far have not clearly demonstrated the value of these on well-worked lands; there are, however, indications that the time is approaching when they may be needed to augment the limited supply of pen and other organic manures. Cotton seed meal is a manure to which increased attention is being given in view of the local supplies available.

At the commencement of the season the grower often finds it difficult to decide which class of cotton he shall plant—that is, whether it would pay him better to grow one of the best "superfine" types or one of the "ordinary" fine types. There is a very limited demand for the specially fine staples, and it is understood that the ready sale or otherwise of these is largely influenced by the prevailing fashions in ladies' wearing apparel. It is estimated that only about 500 bales of these special marks are required by European spinners, and these are chiefly supplied by St. Vincent and St. Kitts. West Indian planters have, however, been recently advised to grow the finest cotton possible and to cultivate for fineness, so that it would appear that the demand for the highest grades of West Indian cotton is increasing, but it may also be due to the fact that the growers of the best kinds of Sea Island in South Carolina are turning their attention to staples of lower grade. The "ordinary fine" will pay better to grow if the difference in price between it and "superfine" does not exceed $2\frac{1}{2}$d. per lb., because it gives a smaller amount of trouble to pick and handle and the ginning yield is much better. From a picker's point of view alone there is a wide margin in its favour, for it has larger bolls, and only from 140 to 160 of these have to be picked to give a pound of seed-cotton, as against 180 to 200 of the best "superfine" types.

The seed is sown by hand when the land is in a moist condition. With seed of tested viability three or four are planted on the ridges in holes from 20 to 24 in. apart according to the fertility of the land. If the seedlings are not seen after a week of good weather has elapsed the holes are resown.

As soon as the seedlings are 4 to 5 in. high they are thinned out to two; a final thinning to one plant in a hole is done three or four weeks later. The time of planting depends almost entirely on weather conditions. In most of the islands planting is started in May—that is, if the rains have come in by that time—but in certain of the northern islands it is sometimes as late as August or September before seed can be sown. In St. Kitts, where cotton is grown as a catch-crop on cane lands, the seed is sown in April, or as soon as possible after this date. June is the favoured month in St. Vincent, but sowings are made from May to the beginning of August.

A prominent member of the Fine Cotton Spinners' Association remarked, when on a visit to St. Vincent, "that the grower of fine Sea Island cotton led a dog's life": and this truthfully describes the cotton grower's lot from the time he sows the seed until the cotton is picked, for spells of dry weather in the growing season may prevent and arrest the germination of the seed, cause excessive shedding of bolls, and wet periods may also cause shedding; the spread of destructive bacterial and fungoid diseases of leaf and boll make weeding impracticable. Insect pests and other troubles may appear suddenly and cause extensive damage; in fact, the planter can never be sure of his crop until he has it under lock and key.

By October the bolls commence to open, and picking is started and continued until February or March. In those islands where the crop is cultivated as an annual one most of the cotton is picked between October and the end of February, and is obtained in average seasons chiefly from the secondary branches. This cotton is known as first pickings. Later or second pickings, as they are called, are obtained from the basal laterals and tertiary branches. The quality of this cotton, however, is not quite as good, as a rule, as that obtained from the first pickings; still, in selecting plants for seed particular attention is given to plants showing this special branching habit, because in unfavourable seasons it often happens that the planter has to rely on his second pickings to avoid a monetary loss on his crop.

The average yield of lint per acre in St. Vincent for the past eight years was 136 lb. The highest average yield in any one season was 175 lb., and the lowest 96 lb. In other islands also there have been similar variations according to season. For the 1912-13 crop the following yields were reported:—

| | | |
|---|---|---|
| Nevis ... | ... 60 lb. of lint per acre. | |
| St. Vincent | ... 98 ,, ,, | |
| Anguilla | ... 125 ,, ,, | |
| St. Kitts | ... 150 ,, ,, | |

In most of the islands there are a few estates where yields of 200 lb. of lint per acre and over are annually obtained, but the general average is much smaller than this, and 150 lb. per acre is considered a fair return in a normal season.

The seed-cotton as brought in from the field is roughly sorted by the picker into two grades, white and stained. It is then sun-dried, and in St. Vincent this operation is nearly always necessary. In no other island in the West Indies have so elaborate measures to be taken to get rid of the excess of moisture usually present in the freshly picked seed-cotton. On some estates a car system is worked, on others drying arrangements closely following the sliding roof and sliding tray principles of cacao "boucans" are used, while the small man has to resort to trays that can be lifted by hand or readily covered with sail-cloth or tarpaulin.

On large estates special buildings have had to be erected in which to store and handle the seed-cotton. After being dried the seed-cotton is bulked in bags or in large heaps for some weeks before it is taken out to be finally cleaned and graded for the ginnery. This practice of bulking improves the character of the lint. After bulking the seed-cotton is graded. Four grades are usually made and are known as first white, second white, first stained, and second stained. The first grade white contains nearly all the cotton from the first pickings, and the second grade white the bulk of the later pickings.

The first grade stained contains some white cotton and some discoloured, and the second grade stained all discoloured. The approximate sale prices of the different grades of "ordinary fine" St. Vincent, with the highest at 22d. per lb., would be second white 18d. to 20d., first stained 10d. to 1s., and second stained 8d. to 9d. per lb. The "stains" represent, as a rule, from 10 to 20 per cent. of the total weight of lint. The quantity of stained cotton is largely influenced by the weather experienced during the ripening season; if dry the percentage is low, if wet it is high. A certain amount of stained cotton may also result from the attacks on the bolls by cotton stainers (*Dysdercus* sp.).

The grading is done on flat basket trays, or benches, the seed-cotton being carefully handled throughout to avoid injury to the lint.

The efficient ginning of West Indian Sea Island cotton is due primarily to a special visit to the islands in 1904 of an expert ginner from the Sea Islands, at the instance of Sir Daniel Morris, to instruct local ginnery officers in the best methods of ginning and baling, and the centralization of most of the work in large ginneries under skilled control. A great deal depends on good ginning, and unless the Macarthy gin is kept in perfect working order the fine and long lint is very liable to be cut or otherwise damaged and its value lowered considerably. At the same time unless the seed-cotton is carefully dried and prepared beforehand the work cannot be satisfactorily performed.

The ordinary West Indian Sea Island seed-cotton of the "Rivers" type yields about 26 per cent. of lint, and the extra fine type 22 per cent. In the former case, therefore, 1,538 lb. of seed-cotton have to be ginned to obtain a bale of 400 lb. net, and in the latter 1,818 lb.

There is a considerable amount of variation in the shape, weight, and size of the bales made in different places. In St. Vincent the lint is all pressed by means of a simple plunger press, worked by hand, in long cylindrical packages 7 by 2½ ft., each containing 360 lb. net. The question has often been asked why this practice is continued when much closer compression could be obtained by using hydraulic or steam presses, and freight saved? The answer to this is that buyers consider the package as best suited to the fine local staple, and advise growers to continue to use it. In other islands square or oblong bales are made weighing anything from 200 to 500 lb. according to the style of press used.

The purchase of seed-cotton from small growers is an important feature of the work of the Government ginneries of St. Vincent and the Virgin Islands and the privately owned ginneries of the other islands. In most cases the seed-cotton is bought outright, but in others a share of the profits made, if any, is returned to the small grower. It may be of interest to give a brief description of the St. Vincent system of purchase on profit-sharing basis, because it is the largest and most successful scheme of its kind in operation in the islands.

The seed-cotton brought for sale is first of all graded on the lines mentioned above, and a payment made on account according to a fixed scale of prices which, during the past season, was for first grade 6¼ cents per lb., second grade 5 cents, third grade 3 cents, and fourth grade 2 cents. At the end of the season, after the lint and seed have been sold, and the purchase, ginnery, and shipping charges have been deducted, a bonus equal to three-quarters of the net profit made is distributed. This is calculated on a percentage basis on the amount paid for seed-cotton and not on the weight of seed-cotton sold. Last season a bonus of 30 per cent. was paid, or 6s. for every £1 worth of seed-cotton. As 6¼ cents per lb. were paid on account for first grade cotton, this meant that the grower received altogether about 8 cents per lb.

From small beginnings in 1909-10 season the annual purchases now amount to over half a million pounds of seed-cotton each season, but include in respect of about one-third of this total "Marie Galante" cotton grown in the Grenadines.

The advantages of the system are many, and its inauguration by the Government has had a very beneficial influence on the industry as carried on by the small man.

In order to describe the many pests and diseases to which Sea Island cotton is subject another paper of considerable length would have to be written. It is only possible to refer briefly to certain of the most important of them here.

In all the islands except St. Vincent the cotton worm (*Alabama argillacea*) is a very troublesome pest, and does a considerable amount of damage each year. Strict watch has to be kept for it throughout the growing season, and Paris green or London purple promptly applied at the commencement of an attack to avoid loss of crop through the defoliation of the plants and the destruction of the young bolls.

The situation in St. Vincent is a novel one, for only two attacks of the "worm," each over a very limited area of the island, have been recorded during the past eleven years, and these, it was thought, were due to two large invasions of moths from the Grenadines, as only fields in the Southern part of the island suffered. The progeny of these moths, however, were so numerous in the district that they could not be dealt with effectively by the planters' friend, the "Jack Spaniard" (*Polistes annularis*), and other natural enemies with which the Colony is so well provided. The control of the "worm" by natural enemies is one of the most interesting features connected with the local industry.

The leaf-blister mite (*Eriophyes gossypii*) is found throughout the West Indies, and is not considered a dangerous pest if the old cotton stalks are thoroughly destroyed by fire at the end of each season and some time in advance of the planting of the following crop. The exceptional situation which has arisen in Barbados in connection with this mite has already been mentioned (p. 305).

In Antigua and Montserrat, but more particularly in the former island, a minute flower-bud maggot (*Contarinia gossypii*) has caused a considerable amount of damage in certain seasons. Early planting appears to offer a means of controlling the maggot; but in Antigua, owing to the low rainfall there, this is not always a feasible practice.

A great deal more might be said of the numerous beetles, bugs, "worms," and scale insects which take their toll of cotton each season, but the most notorious have been mentioned.

In regard to bacterial and fungoid diseases, perhaps the most generally prevalent disease is that caused by "angular spot" (*Bacterium malvacearum*); but in common with other diseases, such as "anthracnose" (*Glomerella gossypii*), boll rot, and mildew, the degree of infection is largely influenced by weather conditions, and in a wet season, or rather, a season when the rainfall is badly distributed, attacks are more severe in character than in a favourable season. In St. Vincent, owing to the high rainfall, more damage is done by "angular spot" and "anthracnose" than in any other island. The line of work that gives most promise of success in minimizing the loss sustained annually by these diseases is the breeding of plants resistant to them. A considerable amount of progress has already been made along this line.

There is no doubt that the Sea Island cotton plant, as grown at the present time, is very susceptible to climatic changes and to the attacks of pests and diseases, and it should be mentioned that efforts are also being made to raise hardier types by hybridization as well as by selection. There are to be found in most of the islands certain "native" perennial cottons which are, as a rule, much more robust than the Sea Island, but which produce inferior lint. Crosses between these and Sea Island are being largely made, and it is hoped that the work will meet with the success it deserves, and enable hybrids to be fixed giving satisfactory yields of fine lint in places where the Sea Island cotton industry is still in a very uncertain condition, and especially in those islands where a remunerative rotation crop with sugar-cane is so much to be desired.

The crop lots of the very fine staples produced in St. Vincent sell at special prices. These during the past few seasons have ranged from 2s. to 2s. 9d. per lb. The best lots of cotton of other growths have realized from 1s. 6d. to 1s. 11d. The prices obtained for the produce of other islands, with the exception of St. Kitts, have always been lower than those named under similar market conditions. The finest St. Vincent and St. Kitts staples, besides being exceptionally strong, fine, lustrous, and uniform, have a length of 2 in. and over. The length of "ordinary fine" West Indian ranges from $1\frac{3}{4}$ to 2 in. Fine Egyptian cotton and some of the American grown Sea Island, as stated before, compete with the lower grades of West Indian Sea Island, and on this account the latter are difficult to sell to-day at a paying price. It should be mentioned that recently one of the finest crop lots of

St. Vincent cotton has been spun into a yarn of 400 "count," which gives a length of 190 miles to the pound. The usual spinning "counts" of West Indian cotton, however, range from 160's to 400's.

The chief fabrics in which the yarn is employed are:—

| | |
|---|---|
| Fancy millinery laces, | Lisle gloves, |
| Tulles, | Shirt labels, |
| Aeroplane sails, | Embroidery cottons, |
| Cotton cambrics, | Typewriter ribbons, |
| Handkerchiefs, | Union cloth for umbrellas, |
| Lawn and other muslins, | Fine hosiery. |

This paper may be fittingly concluded with an extract from the presidential address of Dr. Francis Watts, the Imperial Commissioner of Agriculture, delivered at the West Indian Agricultural Conference, held in Trinidad in 1912:—

"As is usually the case with any new industry, the cotton industry in its revival has passed through many vicissitudes. In some Colonies its reintroduction has not been attended with the full measure of success that was looked for, but in many places its progress and expansion have exceeded the most sanguine expectations, so that to-day cotton growing forms the staple industry of St. Vincent, Montserrat, Nevis, Anguilla, and the Virgin Islands, and is a prominent feature in the agriculture of Barbados and St. Kitts. Considerable interest in cotton growing is taken in Tobago, while in Antigua, where it has met with peculiar difficulties, the industry shows signs of reviving. In Carriacou and Grenada interest in this crop is increasing.[1]

"The reintroduction of cotton affords a striking instance of the value of associated action extending beyond the confines of any one small Colony. It is safe to say that, without the almost simultaneous introduction of cotton growing into a number of islands possessing most diverse conditions, without the interchange of information, coupled with the study of cotton pests,

[1] Increased interest in Sea Island cotton is now being taken in Jamaica also.

diseases and difficulties, rendered possible by such an organization as the Imperial Department of Agriculture, and without the readily available help as regards all that concerned markets and their requirements, focussed and rapidly applied by the British Cotton Growing Association, both of which organizations were closely in touch with all that was going on, efforts would have failed in the individual islands from the circumstance of their isolation, and no cotton industry would have come into existence: the pioneers would have been beaten in detail, but were saved by being united."

## THE COTTON INDUSTRY OF THE LEEWARD ISLANDS COLONY.

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IN the present paper an account is given of the development of the cultivation of Sea Island cotton in the Leeward Islands Colony of the British West Indies, and the position occupied by the industry at the present time.

For the successful growth of the crop a set of highly specialized conditions are essential in the direction of soil, climate, and environment; these, the natural features of the majority of the small islands comprising the group are specially adapted to meet, and at the present time rather more than half of the total export of fine cotton from the British West Indies comes from the Leeward Islands.

The Colony lies between latitudes 15° and 19° North and longitudes 61° to 65° West. Its total area is approximately 675 square miles. For administrative purposes it is divided into five Presidencies, namely, Antigua (including the islands of Antigua, Barbuda, and Redonda), St. Kitts-Nevis (including the islands of St. Kitts, Nevis, and Anguilla), Dominica, Montserrat, and the Virgin Islands (the latter comprising a very numerous collection of small islands). Sea Island cotton is at present cultivated in every Presidency except Dominica.

In the early days of the history of the Colony it is possible that cotton was cultivated to some small extent, but it was soon replaced by sugar. At the time of the American Civil War the cultivation of cotton assumed important proportions in the Colony, but with the cessation of hostilities the industry rapidly declined, the process being hastened, according to popular account, by the ravages of insect pests. In these earlier days the variety of cotton grown was of the short staple type, and the ruined remains of old saw gins, which may still be found at certain places, attest the great, though short-lived, importance to which cotton cultivation attained in the middle years of the nineteenth century.

The rise of the existing industry dates from 1902, in which year commercial trial plantings of Sea Island cotton were made in St. Kitts and Montserrat; these were rapidly followed by similar ventures in other islands in the following year; prior to that small scale experiments had demonstrated that in the cultivation of the Sea Island variety lay the greatest hope of the attainment of successful results.

From that time the industry has developed steadily, and although, as is inevitable, checks and difficulties have been encountered from time to time, these have, for the most part, been successfully surmounted; at the present time the industry must be regarded as having attained a position of considerable stability, while the proceeds derived from it constitute an important fraction of the wealth of the Colony.

In assisting to bring about the development of the industry to the present level, the fostering care bestowed thereon by the local Government and by the British Cotton Growing Association has played a part of the first importance; had this not been forthcoming there is no doubt that the industry would not have developed so rapidly. At the same time the planting community have taken full advantage of the opportunities offered, and, as a result of this cordial co-operation, the present position has been built up.

The assistance alluded to has taken the form of grants and loans in aid of the purchase and erection of machinery for handling the crop, of advances of money on easy terms to prospective cultivators, of the supply of skilled advice and assistance on matters pertaining to the treatment and handling of the crop, and of the provision of ready means of marketing the produce.

From the inception of the industry practically the entire crop has been marketed through the British Cotton Growing Association, while a considerable proportion of the stores and materials required in preparing the staple for market is still procured through that institution.

### *Soils and Climate.*

The soils on which cotton is grown comprise a large variety of types: in St. Kitts, Nevis, Montserrat, the Virgin Islands, and the southern district of Antigua they consist of sands, sandy loams, and loams of volcanic origin; in the northern district of Antigua, Anguilla, and Barbuda, the soils are calcareous, being derived from limestone rocks of varying age. On the whole it may be said that moderately light volcanic soils are best suited to cotton cultivation, although good returns are frequently obtained on calcareous soils and on non-calcareous soils of heavier texture.

The rainfall in the different districts in which cotton is grown ranges from 30 to 70 in. per annum, and in some places even more; where the rainfall is high, however, cotton can only be successfully grown where soil conditions are such as to favour free drainage.

### *Conditions under which the Crop is grown.*

Sea Island cotton is cultivated both as an estates' crop and also by small peasant proprietors.

In Antigua it is grown on estates both as a main crop and as a rotation crop with sugar-cane on sugar estates, while there is a small peasant cotton growing industry. In St. Kitts the crop is chiefly cultivated as an intermediate between two crops of sugar-cane, while it is also grown to some extent as a main crop; in this island there is no peasant cotton growing industry. In Nevis it is grown both as a main crop and also as a rotation crop on sugar estates; while there is a very important peasant industry. In Anguilla the cotton industry is almost entirely in the hands of the peasants. In Montserrat the crop is extensively grown on estates and constitutes the staple crop of the island, while there is also an important peasant industry. In the Virgin Islands the industry is exclusively conducted by peasant growers.

### *Area under Cultivation.*

Owing to the fact that an appreciable proportion of the crop is grown by peasants on small holdings scattered throughout remote districts it is not possible to give an exact figure for the total area under cultivation. At an approximate estimate the average total area cultivated amounts to between 8,000 and 10,000 acres each year. The area fluctuates to some extent from year to year with variations in the market price of the staple, while it will also depend in any one year to some extent on the weather conditions which have prevailed during the preceding season; the crop is especially susceptible to influence by unsuitable weather conditions, and unfavourable seasons invariably result in decreased yields, the effect of which is seen in a decrease in the area planted in the year immediately following.

The industry appears to have established itself at the present level, and it does not seem likely that any very great increase beyond the area stated above is in immediate prospect.

### *Crops and Yields.*

The following tabular statement shows the exports of cotton in pounds of lint from each island and from the whole Colony for each year since the inception of the industry:—

EXPORTS OF SEA ISLAND COTTON (LINT) FROM THE LEEWARD ISLANDS COLONY.

| Year | Antigua, including Barbuda | St. Kitts | Nevis | Anguilla | Montserrat | Virgin Islands | Total |
|---|---|---|---|---|---|---|---|
| | lb. | lb. | lb. | lb. | lb. | lb. | lb. |
| 1902–03 ... | — | 22,880 | — | — | 27,600 | — | 50,480 |
| 1903–04 ... | 27,853 | 24,197 | 28,449 | 1,661 | 70,000 | — | 152,160 |
| 1904–05 ... | 54,289 | 78,219 | 144,721 | 31,452 | 70,723 | 4,100 | 383,477 |
| 1905–06 ... | 99,948 | 120,379 | 120,168 | 80,650 | 98,262 | 6,975 | 526,382 |
| 1906–07 ... | 189,318 | 180,917 | 96,402 | 61,666 | 164,430 | 10,177 | 702,910 |
| 1907–08 ... | 182,180 | 233,006 | 211,431 | 107,989 | 360,000 | 32,520 | 1,127,126 |
| 1908–09 ... | 45,310 | 207,146 | 104,160 | 49,320 | 238,959 | 52,528 | 697,423 |
| 1909–10 ... | 59,960 | 231,441 | 129,063 | 43,400 | 202,542 | 23,139 | 690,154 |
| 1910–11 ... | 96,992 | 329,322 | 343,395 | 148,595 | 402,666 | 50,337 | 1,371,307 |
| 1911–12 ... | 80,910 | 332,168 | 165,329 | 97,142 | 346,568 | 51,677 | 1,073,794 |
| 1912–13 ... | 172,023 | 374,594 | 166,477 | 112,138 | 292,182 | 31,775 | 1,149,189 |

A study of these results will show the rapid manner in which the industry has developed, and also the fact that there appears reason to believe that within the past few years it has settled down to a fairly steady level of production. If an average value of 1s. 6d. per lb. for lint is assumed, the value of the industry during the past three years has ranged between £75,000 and £100,000 per annum, while the total exports for the whole period of eleven years considerably exceed £5,000,000 in value. These figures do not include values for cotton seed, which during the past three years at a moderate estimate have been equal to an additional £7,000 to £9,000 per annum.

It will be further seen that according to the estimate of the total acreage given the yield per acre has averaged from 100 lb. to 150 lb. of lint during the past three years.

### *Seed Supply.*

Sea Island cotton is the most highly specialized variety at present cultivated on an extended scale. Its essential features consist in relatively great length of staple combined with the property known as fineness; for the production of a thoroughly marketable article certain other qualities must also be associated with those already mentioned, namely, regularity in the length of the fibre, adequate strength, freedom from weak and immature fibre, and a high degree of lustrousness.

For the maintenance of these qualities great care is essential in the selection of a suitable seed supply for planting purposes.

At the outset of the industry this was secured through the instrumentality of the Imperial Department of Agriculture for the West Indies, whereby a supply of specially selected seed was procured in 1904 from the Sea Islands of Carolina; this has formed the starting point from which practically all the strains of seed at present cultivated have been derived; had this step not been taken there is little doubt that the development of the industry would in some degree have been retarded.

During the earlier years of the industry the supply of selected seed for planting purposes remained under the direction of the Imperial Department of Agriculture, and for this purpose certain marks of cotton which had been favourably reported on were each year reserved for planting.

With the growth of the industry the actual supply of seed has gradually passed to a large extent into the hands of ginneries, but the advice and assistance of the Agricultural Department continue to be freely sought and given in relation to the selection and preparation of suitable strains for planting.

Investigation has shown that the seed of the Sea Island variety normally possesses a tuft of green fuzz on one or both ends, but that in every crop a certain proportion of seed is produced which is devoid of this tuft (the amount usually ranges from 5 to 20 per cent. of the total). It has further been found that seed lacking this tuft tends to produce lint of inferior quality; consequently, in preparing seed for planting all those seeds which do not possess the tuft in question are removed, together with all immature and aborted seeds. The feature above alluded to, of producing two types of seed, would appear to be an indication that the Sea Island cotton may be of mixed origin in the first instance.

The susceptibility of Sea Island cotton to influence by plant selection is very marked, both in regard to the habit of the plant itself and also in relation to the quality of the lint; for the maintenance and improvement of quality in this respect unremitting labour is necessary. With the duty of carrying on this work the Agricultural Departments in the various islands have charged themselves, and it is gratifying to be able to record that in every Presidency and almost every island in which cotton is grown systematic selections are carried out each year by the Agricultural Department, either at the Government Experiment Stations or on estates in co-operation with local growers; the actual work of field selection and the examination of the lint is in all cases performed by officers of the Department. The selected strains of seed thus originated become available in subsequent years for planting on an extended scale, and in Antigua, St. Kitts, and Montserrat strains of cotton originated in this way are at the present time widely planted.

Experience has demonstrated that as the result of local climatic and soil conditions each island has shown a tendency to produce a type of lint which is characteristic of the locality in which it is produced. That this feature is the result of local conditions and not the outcome of selection is shown by the fact that the differences in question became noticeable when the seed supply for all the islands was obtained from the same source; such marked susceptibility to influence by environment emphasizes the necessity of raising strains of cotton suitable to the conditions under which they are to be grown, and the realization of this point has underlain departmental policy in relation to the industry for a number of years past.

### *Cultivation.*

For the successful growth of the crop careful and thorough cultivation is essential. The tilth of the soil must be maintained, weeding operations scrupulously attended to, and a generally high state of efficiency prevail.

The standard of agriculture in relation to the crop which is maintained throughout the Colony is undoubtedly high. At the present time cultural operations are performed almost entirely by hand, with the exception of the preparation of the land, in which cattle ploughs are employed to a considerable extent. No doubt mule-drawn implements could be, and in some few cases are, successfully employed in weeding operations, though even here they require to be supplemented to some extent by hand labour. At the present time the labour supply available is adequate for the existing industry in the majority of districts, though it is doubtful whether it would allow any further extensions of great magnitude to be made except at the expense of other industries.

### *Planting.*

The actual time of planting depends in a measure on the advent of seasonable weather. In the early stages of growth fairly moist conditions are essential for the successful establishment of the plants. Once the crop is thoroughly established, however, it is able to withstand moderate spells of drought with a fair degree of efficiency, while moderately dry weather is necessary during the ripening of the crop and while picking is in progress; excessive moisture during the latter period is apt to lead to loss owing to boll-dropping resulting from excessive accumulations of water around the root systems of the plants and from bacterial and fungoid diseases.

As a general rule experience has shown that early planting is likely to give the best results, and in St. Kitts, Nevis, and Montserrat the usual months for planting are April and May. In places such as Antigua, Anguilla, Barbuda, and the Virgin Islands, where the rainfall is smaller and more variable in distribution, later planting is practised; as a general rule July may be regarded as the most favourable month for planting under these conditions, but unfavourable weather may cause the operation to be postponed to an even later date. Later planting than July, however, possesses the disadvantage that the crop matures during the months of December and January, at which time the relatively low night temperatures frequently experienced may lead to injury to the crop and result in serious loss.

### *Manuring.*

It cannot be said that any very definite policy in regard to the manuring of cotton has as yet been arrived at. A very extensive series of manurial experiments with the crop has been conducted at the Experiment Station in St. Kitts during the past ten years, in the course of which the same manures have been applied to the same plots year after year; similar trials have also been made for less extended periods in Antigua and Montserrat. The experiments in question have shown that the crop is by no means exhausting, and that on lands in fair tilth a series of crops can be grown for a number of years without manure, and not evince any marked falling off of yield in consequence. This is especially the case on light lands, under which conditions it has been shown that the plants develop a remarkably large root system. It is not implied, however, that manurial treatment is never requisite. When a crop of cotton is grown as a rotation or intermediate crop between two crops of cane no serious consequences may be anticipated from withholding manure from the cotton crop if the cane lands themselves are maintained in adequate condition; indeed, too high a degree of fertility appears inimical, since it tends to develop vegetative vigour at the expense of the reproductive organs. When, however, cotton is grown as a main crop some form of manurial treatment eventually must be adopted. In Montserrat the practice of green manuring for cotton has attained a certain degree of popularity, and up to the present appears well calculated to maintain fertility, although it may in subsequent years require to be supplemented with other manurial dressings.

### *Pests and Diseases.*

The crop is peculiarly liable to attack by a number of pests and diseases, the majority of which are, however, readily capable of control by the timely application of the proper measures.

Among the insect pests the following may be mentioned:—

*The Cotton Worm* (*Alabama argillacea*).—This pest is capable of complete control by dusting with a mixture of Paris green and lime, and although at the outset of the industry some trouble was experienced in connection with the attacks of the insect its control is now thoroughly well understood. In all islands where peasant cotton is grown facilities now exist for the procuring of this insecticide by peasant growers on easy terms; with the exception of Anguilla, this is in every case accomplished through the agency of the Agricultural Depar - ment, a stock of Paris green being maintained by the Government especially for the purpose.

*Leaf-blister Mite* (*Eriophies gossypii*).—This is a pest of more serious importance; it has, however, been shown that by the employment of proper measures it also is capable of control, the most essential feature being the destruction of all old cotton bushes after the crop has been reaped; if this is neglected the old plants serve to harbour the pest and act as centres of infection to the young crop; this process requires to be combined with the hand-picking and destruction of all infected leaves which appear in the early stages of the growth of the crop; dusting with a mixture of sulphur and lime also has some value in assisting to check the spread of the disease.

*Cotton Stainers* (*Dysdercus andreae and D. Delauneyi*).—This pest also has caused a certain amount of trouble from time to time, but has been found to be capable of control by means of suitable traps baited with seed-cotton or cotton seed; the destruction of old cotton is also of importance in checking the spread of this pest. At the present time measures are under consideration with a view to providing legislation for the purpose of enforcing the destruction of all old cotton bushes after the crop has been reaped.

*Flower-bud Maggot* (*Contarinia gossypii*).—This has proved a pest of very serious importance in Antigua and at one time threatened the existence of the industry in that island; it has also been recorded in Montserrat, Barbuda, and the Danish island of St. Croix; the disease is due to the larva of a very small Cecidomyid fly, which attacks the young unopened flower buds and causes their death. No actual remedy has as yet been discovered for the pest, but it has been shown that the disease is apparently seasonal in its incidence and that it is favoured by the relatively low temperature and high humidity characteristic of the months of December and January; in consequence, a palliative has been found to exist in the planting of the crop at such a time as will ensure the development of the flower buds before the incidence of the dangerous season.

*Fungoid and Bacterial Diseases*.—Fungoid and bacterial diseases have not on the whole proved of very great importance in relation to the industry, although losses have from time to time occurred from these causes. Their incidence is usually contingent on the occurrence of exceptionally moist seasonal conditions. Chief among them may be cited angular leaf spot and black arm, anthracnose, and a bacterial disease which causes the discoloration and subsequent shedding of partially matured bolls. No remedial processes have as yet become generally adopted for these diseases, although various measures have been proposed for the purpose.

In certain districts in which the soils are inclined to be heavy in texture losses not infrequently occur as the result of insufficient drainage, as it is not always realized that cotton is a crop liable to suffer from the slightest excess of soil moisture, and requires greater attention in relation to drainage than does sugar-cane.

*Conditions governing the Industry in the different Islands.*

In the following section the conditions under which the industry is conducted in the different Presidencies is briefly considered; the actual exports of cotton in each case are shown in the table on p. 318.

*Antigua.*—In this island the industry has experienced more vicissitudes than anywhere else in the Colony. In the earlier years progress was steady and the area under cultivation rapidly increased until, in 1907, the total area under the crop amounted to 2,500 acres; in this and the following year, however, the ravages of the flower-bud maggot pest made themselves severely felt, and resulted in a very small yield of lint per acre being obtained; in consequence the area cultivated became very greatly reduced until, in 1909, the area planted with the crop only amounted to 253 acres. Since that time much more satisfactory results have been experienced, and the industry has steadily recovered till, during the past season, some 1,200 acres have been under cultivation with the crop.

Cotton is cultivated both on the light volcanic soils of the southern and western area and in the limestone district of the north and east, the former being, on the whole, best suited to cotton growing. The heavy clay soils of the central plain are not so well adapted to the requirements of the crop, although a certain amount of cotton is grown thereon.

The staple is cultivated both as a main crop and as a rotation crop with sugar. In this latter connection it is of importance as affording a means of resting land from cane, thereby lessening the effect of root disease (*Marasmius sacchari*), which is at the present time a source of considerable loss in the sugar industry.

During the years 1905 to 1908 a considerable amount of peasant-grown cotton was produced; in the years following this the peasant industry dwindled to nothing, but has latterly revived again to some extent; the bulk of the cotton grown in this way is purchased locally by licensed buyers, the traffic being regulated by an Ordinance designed to prevent larceny, which requires the registration of both buyers and sellers and the keeping of books recording transactions which must at all times be open to inspection by the police.

There is one ginnery in the island, the equipment of which comprises six Macarthy single action roller gins, a hydraulic baling press, and a seed disintegrator, the plant being driven by a Hornsby-Ackroyd oil engine; it is owned and worked by a local company. The undertaking was originated in 1903 by the local Government, and was worked for three years under the Agricultural Department; it was transferred to the present company in 1906.

*Barbuda.*—This island lies about 25 miles north of Antigua and has an area of 62 square miles; it is worked as a Government estate under the charge of a manager and assistant manager. The undertaking at present combines the growing of cotton and other crops with the raising of stock. From 100 to 150 acres of cotton are cultivated each year; on the whole the undertaking has proved uniformly successful and satisfactory returns have been experienced. There is a ginnery in the island, the property of the Government, which contains two gins, a baling press, and a 4-h.p. oil engine. Till recently the quality of the cotton grown in this island has borne the reputation of being somewhat coarse, but during the past two years systematic selection trials have been undertaken by the management in conjunction with the Agricultural Department, with a view to improving the quality of the cotton; it is hoped that the fruits of this work will shortly be seen in a marked improvement in the quality of the staple.

The effect of the industry on the prosperity of the island has been very marked; prior to the inauguration of the existing undertaking the island was in an exceedingly poverty-stricken condition, the mode of life of the inhabitants was extremely low, and annual grants in aid of the Dependency from Antigua funds were always necessary. With the advent of cotton growing conditions have materially improved, employment has been provided for the population of about 800 souls which the island possesses, and there is a substantial balance to the credit of the enterprise.

*St. Kitts.*—St. Kitts lies about 60 miles to the west of Antigua and has an area of 68 square miles. The industry has established itself very firmly in the island, while the quality of the cotton grown has attained a high reputation.

The greater part of the crop is planted intermediately between two crops of cane; after the first picking has been reaped the trees are pulled up and either burned or buried, and the land planted with cane. This system enables the cultivation to be carried on very cheaply and has given excellent results; a certain amount of cotton is also grown as a main crop. The soils of the island as a whole are particularly adapted to cotton growing; in the south-western area the conditions are almost ideally suited to the crop, in the north-eastern district the heavier rainfall renders the crop more uncertain.

On the whole cotton growing may be said to have attained a more uniform degree of success in St. Kitts than in any other island in the West Indies, and has greatly added to the prosperity of the community.

At the present time from 1,500 to 2,000 acres are planted each year.

There is a large ginnery at Spooner's, on the windward coast, the property of Messrs. Sendall and Wade, the equipment of which includes plant for crushing cotton seed and extracting the oil therefrom; the bulk of the crop of the island is handled at this institution. There is also a smaller privately owned ginnery on the leeward side of the island.

No peasant-grown cotton is produced in St. Kitts.

*Nevis.*—Nevis lies south of St. Kitts and is separated from it by a channel a mile wide at its narrowest point; the total area of the island is 50 square miles.

In Nevis cotton is cultivated as a main crop and, if possible, is kept for a second picking. The crop is grown both on estates and by peasant cultivators, the latter occupying very nearly one-half of the total area under cotton.

Owing to the heavier character of the soil and the rather more uncertain seasons experienced, the returns have been more variable than in the sister island of St. Kitts; but, taken over a period of years, the returns have been satisfactory and the cultivation of the crop has added greatly to the prosperity of the island.

At the present time cotton cultivation has to a very large extent taken the place of sugar-cane, and may be regarded as the staple industry of the island; the area at present cultivated under the crop ranges annually between 1,000 and 2,000 acres.

There is a large ginnery in Charlestown—the capital of the island—which is worked by a London firm, while there are also a number of smaller ginneries at different points.

The important class of peasant growers are well looked after by the Agricultural Department, their plots being regularly visited by the Agricultural Instructor, and advice and assistance given when required. Arrangements are made each year for supplying small growers with selected seed of good quality at cost price, while facilities are also afforded for the obtaining of Paris green for the control of cotton caterpillars.

The produce of the peasant cultivators is largely disposed of by local sale, the traffic being regulated by an Ordinance similar to that which is in operation in Antigua.

*Anguilla.*—In this small island, the area of which is 35 square miles, the growing of Sea Island cotton has also played a very important part. With the exception of that which is produced by one large grower, Mr. C. Rey, the cotton is entirely grown on small holdings by peasants. The conditions are often rendered unfavourable on account of drought and the wind-swept state of the island; in consequence the average return per acre is lower than in St. Kitts and Nevis.

The total area planted each year ranges between 600 and 1,200 acres.

Mr. C. Rey, who owns a large ginnery, has done much to foster the growth of the industry, and it is to his efforts that the present position is largely due. Loans are annually granted to him by the local Government and the British Cotton Growing Association which enable him to make advances to small cultivators while the crop is being grown, and almost the entire output of the island is marketed through him. The effect of the industry has been most marked in affording a measure of prosperity to this small island, where formerly the conditions were of extreme poverty.

*Montserrat.*—Montserrat lies 27 miles south-west of Antigua and has a total area of 32½ square miles.

The cotton industry is of prime importance in the island and occupies the position of staple crop. The total area cultivated ranges from 2,000 to 2,500 acres. The industry has assumed an assured position and the acreage under the crop on estates does not vary much from year to year; the fluctuations which have occurred in the total area planted during recent years have been very largely due to the varying interest shown by the peasant proprietary.

The soils of the lower coast lands of the island are on the whole very well adapted to cotton growing, but on the higher lands in the central region of the island soil and climatic conditions tend to render the crop more uncertain.

There are several privately owned ginneries in the island, the majority of which, in addition to handling the crops of estates, also purchase the produce of peasant growers. Here, as in other Presidencies, trading in cotton is regulated by a local Ordinance.

The effect of the introduction of cotton growing has been most beneficial, and has served to place the island in a sound financial position; prior to the inception of the industry the condition of the island was one of considerable depression.

Generally the outlook for the industry is promising; as a result of satisfactory returns considerable increases have taken place in the area planted with the crop by peasants. Large tracts of land have been reintroduced into cultivation which for many years previously have been in bush, and regular employment has been found for a considerable section of the labouring community.

*The Virgin Islands.*—This Presidency consists of a very numerous group of small islands lying about 200 miles north-west of Antigua; the largest members of the group are Tortola, Virgin Gorda, Anegada, and Jost van Dyck's; the total area of the Presidency is about 30 square miles. There are no properties worked on estate lines and the land is very largely in the hands of the peasants.

Formerly the conditions of the islands were of extreme poverty, but the reintroduction of cotton cultivation has served materially to improve the condition of affairs.

The crop is entirely produced by peasant cultivators on small holdings, which are often situated in remote and isolated situations.

The industry has been developed through the enterprise of the Government by means of the Agricultural Department. Each year a supply of selected seed of good strain is provided for planting purposes and supplied to intending growers at low rates.

A ginnery, containing two gins, a baling press, and an oil engine, has been erected by the Government, and the seed-cotton produced is there purchased from growers at prices based on the current market values for lint, the produce being subsequently exported and sold.

Guidance and advice on the treatment of the crop are afforded by frequent visits of the agricultural officers to the holdings of peasant cultivators, while facilities are also given for the control of pests and diseases.

As in other places where peasant cotton growing is carried on, the industry has been largely built up as the result of efforts on the part of the Agricultural Department, including the provision of a ready means of marketing the staple once it has been produced.

The effect is seen in the greatly ameliorated conditions under which the inhabitants of these islands now exist and the improved financial outlook of the Presidency.

### *Conclusion.*

The foregoing pages present a fairly comprehensive outline of the conditions under which Sea Island cotton is produced in the Leeward Islands Colony, and indicate the important economic results which have followed the introduction of the industry. Both on estates and among peasant growers its effects have been far-reaching, and it is worthy of remark that these results have been attained in a comparatively short space of time.

The permanence of the industry now appears to be mainly contingent on two factors, namely: (1) The continuation of satisfactory market conditions; and (2) the non-appearance of any wholesale destructive agency in the shape of disease which may jeopardize the existence of the industry.

Given a continuation of existing conditions, there is no reason why the industry should not be regarded as firmly established.

At all points a considerable store of knowledge has now been accumulated by growers as to the best methods to be adopted in producing the crop; but, in the case of a highly specialized product such as this, there is still room for a certain degree of increased appreciation on the part of growers of the exact requirements of spinners, and it may perhaps be added on the part of spinners of more detailed knowledge of the conditions under which the crop is grown.

There does not appear to be any real reason, if these two factors are correctly apprehended, why the requirements of spinners should not be met with even greater exactitude than at present, but the essential feature must not be lost sight of that each island will always tend to produce its own type of lint, and that it is by reselection of acclimatized strains that improvement is most likely to be effected, rather than by importation of fresh strains from outside sources.

The general history of the industry is of interest and also serves to indicate the steps which are most likely to lead to success in fostering the development of other industries under similar conditions.

## BAUMWOLLBAU IN DEUTSCHEN KOLONIEN.

Von MORITZ SCHANZ.

*Chemnitz.*

DIE Entwicklung der Exportkultur von Baumwolle in den drei deutschafrikanischen Kolonien, Togo, Kamerun und Ostafrika, hat seit dem Jahre 1910 stetige Fortschritte gemacht und zwar erfolgt die gemeinnützige Förderung dieser wichtigen Bestrebungen nach wie vor durch das Zusammenarbeiten der Regierungsorgane und des Kolonial-Wirtschaftlichen Komitees, laut dem am 14. März 1910 abgeschlossenen Uebereinkommen, das sich durchaus bewährt hat.

In Togo hat man, da Kronland dort nicht vorhanden, das Land vielmehr überwiegend im Besitz der Eingeborenen ist, auch die Baumwollkultur von vornherein als Klein-oder Volkskultur, nicht als Plantagenkultur unter Leitung europäischer Besitzer geplant und der Erfolg hat die Richtigkeit dieses Vorgehens bewiesen. In ziemlich stetiger Zunahme stieg die Ernte von 40 Ballen à 250 kg. im Jahre 1901 auf 2,200 Ballen im Jahre 1912, im Werte von 514,000 Mark. Die Zahl der in den verschiedenen Teilen der Kolonie arbeitenden Entkernungsanstalten beträgt 12. Ungünstig beeinflusst werden die Ernteerträge durch den Umstand, dass die Wiederschläge nicht immer genügend sind. Dagegen zeigen die in Togo auftretenden Baumwoll-Krankheiten und Schädlinge bislang keinen ernsten Charakter.

Der von den Eingeborenen überwiegend in Misch-, nicht Reinkultur und noch mit recht ungenügenden Kulturmethoden betriebebe Baumwollbau beschränkt sich, soweit der Export in Frage kommt, im Wesentlichen auf Süd- und Mittel-Togo, wo man mit Ausnahme des Küstengürtels heute nur noch die hier längst vorhandene und akklimatisierte "Togo Sea Island" anbaut, die einer guten amerikanischen "middling" entspricht und deren Faser nach einem wohl hauptsächlich durch

Mischung verschiedener Sorten entstandenen Qualitätsrückgang in den Jahren 1908/10 jetzt in Länge, Stärke und Glanz wieder zufriedenstellend ist, seitdem die Regierung Zucht und Verteilung reiner Saat systematisch und mit Erfolg durchgeführt hat. Für das in Bezug auf Ausfuhr weniger günstig gestellte Nord-Togo wird eine geeignete Baumwollsorte noch gesucht.

Das Kolonial-Wirtschaftliche Komitee besitzt seit 1908 nicht mehr einen ständigen Vertreter in Togo, leistet aber nach wie vor die Garantie eines Minimalpreises und stellt Prämiengelder zur Verfügung zur Verteilung an Eingeborene für besondere Leistungen im Baumwollbau.

Die Preisgarantie in Togo beläuft sich zur Zeit auf 30 Pfennige für $\frac{1}{2}$ kg. entkernter Baumwolle loko Eisenbahnstation, an welcher Ginanlagen im Betrieb.

Dem Gouverneur von Togo stehen vier landwirtschaftliche Sachverständige und fünf Bezirkslandwirte zur Verfügung, die ihr besonderes Interesse dem Baumwollbau zuwenden und die letzteren wirken im gleichen Sinne auch als Wanderlehrer unter den Eingeborenen. Die vom Kolonial-Wirtschaftlichen Komitee übernommenene Versuchsanstalt Nuatscha wurde 1912 seitens der Regierung unter Beibehaltung des Lehrbetriebs für Eingeborene zur Landeskulturanstalt ausgebaut und ergab 1912/13 in ihrem feldmässigen Anbau von Baumwolle einen Durchschnittsertrag von 484 kg. Samenbaumwolle auf den Hektar. Daneben unterhält die Regierung auch noch drei besondere Baumwollstationen in den Bezirken Atakpame, Misahöhe und Sokodé.

Um die Massnahmen zur Hebung der Baumwollkultur wirksam zu gestalten, hat sich die Notwendigkeit einer am 9. Januar 1914 erlassenen Baumwollordnung betreffs Handel und Aufbereitung von Baumwolle herausgestellt. Demnach darf Baumwollsaat an Farbige nur von der zuständigen Verwaltung abgegeben werden. Aufkäufer werden zum Baumwoll-Aufkauf nur mit einen Erlaubnisschein zugelassen, der von der Bezirksleitung für die Dauer eines Jahres kostenlos ausgestellt wird. Die zu Aussaatzwecken bestimmte Baumwollsaat ist in Säcken mit Herkunftsbezeichnung trocken zu lagern; Unbefugte dürfen keinen Zutritt zu den Lagerräumen erhalten.

Im Interesse der Züchtung frühreifer Sorten wird neuerdings im ganzen Schutzgebeit grundsätzlich die Saat der ersten Pflücke zür Verteilung und Aussaat benutzt.

Der Baumwoll-Export Togos ist noch steigerungsfähig, scheint aber kaum je eine besondere Ausdehnung erlangen zu können und die früher gehegten weitgehenden Erwartungen waren jedenfalls zu hoch gespannt.

Recht aussichtsreich liegen dagegen die Vorbedingungen für weite Teile von

Kamerun, sobald erst einmal das Innere durch Eisenbahnen erschlossen sein wird. Das Waldland und namentlich die Küste dürften wegen der teilweisen phänomenal hohen Niederschläge und zu kurzer Trockenzeit allerdings für Baumwollbau ganz ungeeignet sein; um so besser aber eignen sich dafür die im Hinterland gelegenen Grasländereien. Baumwolle ist wildwachsend in ganz Adamaua und im Tsadsee-Gebiet verbreitet und wird südlich vom Tsadsee, ebenso wie im Alluvial-Gebiet des Benuë noch heute von den Eingeborenen vorläufig nur für ihren eigenen Bedarf, in mehrjähriger Kultur und in grossem Umfang angepflanzt. Es steht hier eine dichte und intelligente Ackerbau treibende Bevölkerung zur Verfügung und zwar dürften sich für eine Baumwoll-Exportkultur in erster Linie die Heidenstämme, weniger die Mohamedaner eignen.

Schwierigkeiten bietet aber verläufig noch der Abtransport, da zunächst nur der ungenügende Wasserweg auf dem Niger-" Benue" in Frage kommt.

Die schon früher in Aussicht genommenen amtlichen Schritte zur Klärung der Baumwollfrage in Kamerun begannen 1911 mit der Entsendung eines Sachverständigen nach dem Bezirk Bamum, wo Baumwolle als Kulturpflanze der Eingeborenen vorkommt, früher feldmässig angebaut worden sein soll, dann aber bei Vordringen billiger europäischer Gewebe vernachlässigt wurde. Die Aussichten für Baumwollbau, wobei als Wirtschaftsform zunächst nur die Förderung der bereits von altersher bestehenden Eingeborenen-Kultur in Frage kommen kann, sind aber noch heute durchaus günstig und die Regierung richtete 1912 in vorsorglicher Weise speziell zur Hebung des Baumwollanbaus zwei landwirtschaftliche Versuchsstatioen in Bamum und Garua ein. Denselben liegt ob, zunächst die geeignetsten Baumwollsorten herauszufinden und zu züchten, die Eingeborenen zur Baumwoll-Exportkultur zu erziehen ud weisse und farbige Wanderlahrer heranzubilden, damit die Ausdehnung der Kultur auf gesunder Grundlage erfolgen kann, sobald verbesserte Transportmöglichkeiten sie lohnend machen.

Nachdem die Transportfrage mehr geklärt sein wird, beabsichtigt das Kolonial-Wirtschaftliche Komitee dem Kaiserlichen Gouvernement die Mittel für den ersten Ankauf der deutschen Adamaua-Baumwolle zur Verfügung zu stellen, um diese der heimimischen Industrie zuzuführen.

Die grössten Hoffnungen betreffs kolonialen Baumwollbaus aber setzt man in Deutschland auf

D e u t s c h - O s t a f r i k a, Man arbeitete auch hier zunächst nach amerikanischen Methoden. Da sich bei den Anbau-Versuchen mit fremd Sorten aber herauszustellen schien, dass die hochklassigen ägyptischen Sorten Abassi und Mitafifi die besten Resultate ergaben, so ging man begreiflicherweise ganz zu diesen über und das Gouvernement verbot 1904 die Einfuhr amerikanischer Saat nach Ostafrika überkaupt. Erzielte man mit den wertvollen ägyptischen Sorten in den niedrigen Lagen der Küstengebiete stellenweise auch recht günstige Resultate, so fand man ab 1909 doch heraus, dass die in den benachbarten englischen Kolonien Uganda und Nyasaland akklimatisierten amerikanischen Upland-Sorten sich auch in Deutsch-Ostafrika im allgemeinen als widerstandsfähiger erwiesen und hat darauf heute auch bei uns den Hauptteil der Produktion eingestellt.

Leider besitzt Deutsch-Ostafrika keine grosse einheitliche Baumwollzone, sondern eine Anzahl, kleinerer Baumwollgebiete von sehr verschiedenem Charakter, so dass überall besondere Studien nötig sind.

Als grösstes Hindernis der Baumwollkultur in Deutsch-Ostafrika erwies sich bald die Unsicherheit der meteorologischen Verhältnisse und zwar handelt es sich dabei teils um Regenmangel, teils um Regen zur unrechten Zeit. Ersterer wäre in den Perioden ausserordentlicher

Trockenheit, von denen das Schutzgebiet nicht selten heimgesucht wird, durch künstliche Bewässerung auszugleichen, die man in Ostafrica nach ägyptischen Muster überhaupt zur Sicherung der Ernten vielfach im Auge haben muss und für welche seitens des Kolonial-Wirtschaftlichen Komitees bereits Vorarbeiten geleistet wurden, die der Verwertung durch Interessenten harren; weit bedenklicher und nicht auszugleichen ist aber der unzeitgemäss d.h. während der Kapselreife einsetzende Regen, der nur zu leicht das Verderben der Faser herbeiführen und die ganze Ernte gefährden kann.

Regenmenge und Regenverteilung sind gleichmässiger im Süden des Schutzgebiets mit seiner einen Regen- und einer Trokkenzeit, als im nördlichen Küstenland, und besonders günstig liegen die Verhältnisse im Hinterland von Lindi und Kilwa, wo der Niederungsboden vielfach vortrefflich ist. Auch Kissaki liefert Baumwolle von hervorragender Qualität und im Bezirk Muansa am Victoria-See sind Boden- und klimatische Verhältnisse sehr ähnlich denen von Uganda.

Es ist anfangs viel darüber gestritten worden, ob der Baumwollbau im tropischen Afrika als Kleinbauern-Negerkultur, oder als Plantagenkultur betrieben werden solle. Dieser Streit dürfte heute als erledigt zu betrachten sein und zwar nach der Richtung hin entschieden, dass man das Problem nicht mehr auf "Klein- o d e r Plantagenkulturen" einstellt, sondern auf "Klein- u n d Plantagenkulturen," und dass man je nach den örtlichen Bedingungen insbesondere mit Rücksicht auf Landbesitz- und Arbeiterverhältnisse, das eine oder das andere bevorzugt. Allgemein zutreffende Lehren lassen sich darüber nicht aufstellen, vielerorts können beide Wirtschaftsformen nebeneinander hergehen.

Das trifft z.B. für Ostafrika zu, wo das Land nicht, wie in Togo, überwiegend unter den Eingeborenen aufgeteilt ist, sondern ausgedehnte, für Baumwollbau geeignete Ländereien zu billigen Bedingungen dem Europäer kauf- oder pachtweise zur Verfügung stehen, die Möglichkeit einer Gross-Plantagenkultur in europäischen Besitz und unter europäischer Leitung also durchaus gegeben ist. Dieser Plantagenbau wirkt dann auch anregend und belehrend auf die Eingeborenen zurück. Ueberhaupt wird sich der afrikanische Neger auf eine neue Exportkultur nur dann einlassen, wenn ihm der Antrieb dazu von aussen kommt, sei es nun durch die Nachbarschaft europäischer Plantagen und Kaufleute namentlich wenn diese es verstehn, die Häuptlinge direkt dafür zu interessieren; sei es durch eine starke Vermehrung der Bevölkerung durch welche die Konkurrenz erweckt wird; sei es endlich durch einen sanften Druck der europäischen Behörden, indem z.B. die Bezirkshauptleute den eingeborenen Autoritäten, den Jumben und Akidas, immer wieder ihre betreffenden Wünsche äussern, oder indem sie Steuern einführen, welche den Anbau von Geldernten notwendig machen, oder auch durch Einwirkung der Bezirkslandwirte, welche auch eine fortgesetzte Kontrolle auszuüben haben, da ohne eine solche die neuen Produktionsarten nicht sachgemäss fortgesetzt werden.

Besonders schwer ist dabei zu beurteilen, wieviel man den Eingeborenen mit neuen Kulturen zumuten kann, ohne andere wichtige und einträgliche Kulturen zu schädigen. Eine Schwierigkeit bei Einführung jeder neuen und noch nicht ausprobierten Volkskultur für den Export liegt auch darin, dass der Neger durch Missraten einer Ernte leicht in eine Notlage gebracht und dadurch entmutigt werden kann.

Zur Hebung der Eingeborenen-Baumwollkultur in Ostafrika, die man von Anfang an als besonders wichtig anerkannte und dementsprechend förderte, gründete das Kolonial-Wirtschaftliche Komitee eine Baumwollschule am Rufiji, und die Regierungsstationen und die Missionen machten in ihren Bezirken Propaganda für den Baumwollbau. Bislang pflanzen die Eingeborenen Baumwolle meist mit Mais, Bohnen, Hirse und Kassada zusammen und besonders Mais bildet eine häufige Vor-oder Zwischenfrucht mit Baumwolle.

Ab 1908 und durch die Dernburg'sche Reise angeregt sicherten sich grosse deutsche Spinner bedeutende Ländereien in Ostafrika, um dort zukünftig einen Teil ihres Bedarfs an Rohbaumwolle durch eigene Plantagen zu decken. Daneben bauten auch mittlere und kleinere weisse Pflanzer Baumwolle an, gewöhnlich in Zwischenkultur mit Manihot, Kautschuk, Sisal-Agaven und Kokospalmen, wenn auch an deren Stelle letzthin mehr und mehr der Baumwollbau als Reinkultur Platz greift.

Die Zeit ist noch zu kurz, um heute schon sagen zu können, welche dieser verschiedenen Betriebsformen in ostafrikanischen Pflanzungen sich lohnen werden.

Bislang bringt die Eingeborenen-Kultur grössere Mengen Baumwolle, als die Plantagenkultur und der Baumwollbau der Eingeborenen gewinnt ständig an Ausbreitung und Beliebtheit, wenn auch nicht in allen Teilen des Schutzgebiets in gleicher Weise. Es findet vielmehr von Jahr zu Jahr schärfer eine Trennung der für diese Kultur geeigneten und ungeeigneten Gebiete statt. Nur in den sich endgültig als Baumwollgebiete erweisenden Gegenden wird auch weiterhin diese Kultur gefördet werden, wobei man gleichzeitig besonderes Gewicht auf den genügenden Anbau von Nahrungsmitteln legt. Die von den Eingeborenen mit Baumwolle bestellten Flächen lassen sich schwer schätzen, die Fortschritte der Eingeborenen-Kultur gehen aber am gesten aus der von Jahr zu Jahr steigenden Nachfrage nach Saatgut hervor, welche 1910-11 rund 3,000; 1911-12, 6,000; und 1912-13, 10,000 Zentner betrug, während für die Saison 1913-14 beantragt waren:—

8,050 Zentner Nyasa-Upland für die Bezirke Lindi, Kilwa, Rufiji und Daressalam.
2,200 Zentner Uganda-Upland für die Bezirke Muansa.
600 Zentner ägyptiche Assili für die Bezirke Bagamoyo und Sadani.
170 Zentner verschiedener Sorten.

In den letzten Jahren haben aber auch die Plantagen im Lindi- und im Kilossa-Bezirk sowie am Rufiji, erfreulicherweise wieder festeren Fuss gefasst, nachdem grosse, mitlere und kleinere Europäerpflanzungen aus verschiedenen Ursachen ihren Betrieb einstellten. Im Jahre 1912 waren von Europäern 12,900 Hektar mit Baumwolle bestellt und im ganzen ist die Baumwollernte Ostafrikas von 37 Ballen zu je 250 kg. in 1903 auf 7,526 Ballen in 1912 gestiegen. Davon entfielen auf die Jahre

| | | | | | | |
|---|---|---|---|---|---|---|
| 1910: | 3,581 | Ballen | im Werte | von | 751,000 | Mark. |
| 1911: | 4,322 | ,, | ,, | | 1,331,000 | ,, |
| 1912: | 7,526 | ,, | ,, | | 2,110,000 | ,, |

Soweit Europäer im Baumwollbau nicht reüssierten, ist es vielfach dem Umstand zuzuschreiben, dass sie in Verkennung der eigenartigen meteorologischen Verhältnisse Ostafrikas ungeeignete Böden und Sorten wählten; ferner lässt sich nicht leugnen, dass der Wunsch, Rodungskosten zu sparen, bei gleichzeitigem Vertrauen auf die Wirksamkeit moderner Kulturgeräte, die europäischen Pflanzer stellenweise Böden zum Baumwollbau heranziehen liess, die als ungeeignet dafür bezeichnet werden müssen, weil sie zu kümmerlichem Gedeihen der Pflanze führen und eine natürliche Prädisposition für Krankheitsbefall aller Art, besonders die stellenweise verhängnisvoll aufgetretene Kräuselkrankheit schaffen. Auch wurde leider vielfach der durchaus nötige Fruchtwechsel nicht angewandt, sondern Jahr für Jahr auf demselben Felde Baumwolle gepflanzt. Die meisten Landwirte, die zum ersten Male in die Kolonien gehen, haben überhaupt noch gar keine Erfahrungen im Baumwollbau und in der Beurteilung von Baumwolle; Erfahrungen müssen vielmehr auch sie erst draussen lernen. Allmählich aber wachst auch uns ein Stamm gereifter Pflanzer heran, die in unseren Kolonien festen Fuss gefasst haben.

Nach dem im März 1910 zwischen Reichs-Kolonialamt und Kolonial-Wirtschaftlichem Komitee getroffenen Uebereinkommen betreffs Arbeitsteilung leistet das letztere in Ostafrika heute in erster Linie die folgenden gemeinnützigen Dienste:—

(1) Ankauf, Bearbeitung und Lieferung von ausgesuchter einheimischer und fremder Baumwollsaat seitens der Geschäftsstelle des Komitees in Daressalam, zur kostenlosen Verteilung durch die Regierungsstellen an Eingeborene und hilfsbedürftige europäische Pflanzer; die grösseren Pflanzer decken ihren Saatbedarf selbst.

(2) Leistung der Garantie für Mindestpreise zum Schutze der eingeborenen Bevölkerung gegen plötzlichen Preissturz, und Selbstaufkauf zu diesen Preisen seitens des Komitees, falls Aufkäufer nicht vorhanden sind, oder

die aufkaufenden Händler diese Preise unterbieten. Hat sich die Baumwollkultur erst einmal fest eingebürgert, so werden Preisschwankungen, sowie vereinzelte ungünstige Ernteausfälle die Eingeborenen kaum mehr abschrecken, da derartige missliche Zwischenfälle ihre alten Kulturen ebenso treffen. Die Preisgarantie beträgt zur Zeit:—

Je nach Güte 8-10 Heller für ½ kg. unentkernter ägypt. Baumwolle, u. nach Güte 5-6 Heller für ½ kg. unentkernter Upland-Baumwolle franko Bahnstation, bezw. Hafen.

(3) Unterhaltung eines eigenen Saatwerks in Daressalam zur mechanischen Reinigung und Sortierung der einheimischen Saat, in Verbindung mit dem Betrieb einer Anstalt zum Entkernen und Packen der Rohbaumwolle.

(4) Ständige Ausstellung in Daressalam von landwirtschaftlichen Maschinen Geräten und Ernteaufbereitungs-Anlagen, alles deutsche Erzeugnisse.

(5) Anlage eigener Entkernungs-Anstalten auch ausserhalb Daressalams, z.B. in Lindi, und Lieferung solcher an Interessenten zum Selbstkostenpreis gegen Abzahlung in drei Jahresraten.

(6) Unterhaltung von technischen Beratungsstellen in Daressalam, Tanga und Lindi, welche gegen Erstattung der Kosten den Besitzern der Entkernungs-Anlagen—heute bereits 37—begutachtend zur Seite stehen sollen. Daneben ist für 1914 die Einrichtung einer Maschinistenschule in Daressalam geplant, um farbige Maschinisten zu einer zuverlässigen Behandlung der Baumwollmaschinen heranzubilden.

(7) Förderung des Eisenbahnbaus, des Ausbaus der Wasserstrassen, Vorarbeiten für Be- und Entwässerung. So hat das Komitee dem Kaiserlichen Gouvernement von Ostafrika zum beschleunigten Ausbau der 40 km. langen Baumwollfeldbahn im Lindi-Bezirk im Jahre 1913 50,000 Mark überwiesen und neuerdings die finanzielle Förderung einer Bahn nach dem für Baumwollbau aussichtsreichen Kissaki-Bezirk, sowie eine wasserwirtschaftliche Expedition im Interesse der Verbesserung des Rufiji-Schiffahrtswegs in Aussicht genommen.

Während dem Kolonial-Wirtschaftlichen Komitee also mehr die kaufmännisch-technischen Arbeiten zufallen, haben die amtlichen Organe der Regierung die folgenden Aufgaben übernommen:—

Sie errichten und betreiben in den Kolonien landwirtschaftliche Stationen mit besonderer Berücksichtigung von Baumwollsortenversuchen, Saatzucht, Düngung und Bewässerung; sie organisieren die Bekämpfung von Baumwoll-Schädlingen und Krankheiten; betreiben die wissenschaftliche Untersuchung von Baumwollböden und den meteorologischen Dienst, sowie eine geeignete Einwirkung auf die Eingeborenen-Bevölkerung, sich dem für die deutsche Nationalwirtschaft so wichtigen Baumwollbau zu widmen.

Zur Durchführung dieses Programms steht dem Gouvernement in Ostafrika ein besonderer Referent für Landwirtschaft zur Verfügung, dazu acht Bezirkslandwirte, die gleichzeitig als Wanderlehrer für Eingeborene wirken und die unter ihnen als Gehülfen arbeitenden farbigen Wanderlehrer überwachen, welche das Land zur Belehrung und Kontrolle der Eingeborenen fortgesetzt bereisen; endlich zwei Spezialisten zur Untersuchung und Bekämpfung von Baumwollschädlingen und Krankheiten. Das Reichs-Kolonialamt ist bemüht, tüchtige landwirtschaftliche Kräfte ausfindig zu machen und nach den Kolonien hinauszusenden, die neben einer gründlichen praktischen Schulung auch eine gute wissenschaftliche Durchbildung aufweisen können und die Regierung hat bei der Auswahl dieses Personals im allgemeinen eine recht glückliche Hand gehabt.

Eine verdienstvolle Wirksamkeit entfalten ferner das 1902 gegründete landwirtschaftlich-biologische Institut in Amani und 6 auf die Hauptbezirke verteilte Baumwollstationen, darunter das 1904 vom Kolonial-Wirtschaftlichen Komitee als Baumwollschule begründete und 1910 vom Gouvernement unter Beibehaltung des Schulbetriebs für Eingeborene übernommene Mpanganya.

Das Arbeitsprogramm dieser Baumwollstationen umfasst:—

(1) Vergleichende Anbauversuche zur Ermittelung der für die betreffenden Bezirke geeigneten Baumwollsorten, unter Berücksichtigung der Ertragshöhe, der Faserqualität und der Widerstandsfähigkeit gegen Krank-

heiten und Schädlinge; ferner Akklimatisierung hochwertiger und ertragreicher Typen aus fremdländischen Produktionsgebieten.

(2) Züchtungsversuche zur Verhinderung des Abbaus und der Entartung der ausgewählten Sorten und zur stetig fortschreitenden Verbesserung aller in Betracht kommenden wertvollen Eigenschaften, durch Massen- und Individualauslese und Leistungsprüfung, um ertragreiche, hochwertige Lokalrassen mit sicheren Erträgen zu erhalten.

(3) Vermehrung der für den Anbau im Grossen bestimmen Sorten und Rassen zur Gewinnung grösserer Mengen von Saatgut für die Verteilung im Anbaubezirk.

(4) Versuche zur Feststellung der zweckmässigsten Aussaat- und Erntezeiten, sowie zur vergleichenden Prüfung verschiedener Kulturmethoden, europäischer Geräte und Maschinen zur Bodenbearbeitung, Bestellung, u.a.

(5) Fruchtwechselversuche mit anderen Feldfrüchten, insbesondere für die Ernährung der Eingeborenen und zum Export; in Verbindung damit Düngungsversuche einschliesslich solcher mit Gründüngung.

(6) Versuche mit der Haltung von Rindvieh zur Leistung von Feldarbeiten als Ersatz menschlicher Arbeitskräfte und zur Produktion von Dünger.

(7) Soweit notwendig, Bewässerungsversuche zu Baumwolle, Feststellung der dabei entstehenden Kosten und des Einflusses auf Menge und Güte der Erträge und auf die Empfindlichkeit gegen Krankheiten und Schädlinge.

(8) Beobachtungen und Versuche, betraffend Baumwoll-Krankheiten und Schädlinge, sowiederen Bekämpfung.

(9) Beratung und Belehrung von Pflanzern und Eingeborenen in allen Fragen der Landwirtschaft, speziell im Baumwollbau.

(10) Ausbildung farbiger Wanderlehrer. Die Zehl der auf den staatlichen Baumwollstationen zur Ausbildung untergebrachten Farbigen ist letzthin weiter vermehrt worden. Bei genügender Kontrolle durch die Bezirkslandwirte haben sich die Leute im allgemeinen gut bewährt.

Einen der wichtigsten Punkte bildet natürlich die Saatfrage.

Bisher wurde die meiste Saat von Ausland und zwar aus Aegypten bezogen. Die Regierung trachtet jetzt aber danach, die Saat im Lande selbst zu gewinnen. Zu diesem Zwecke wurden die Saatzuchtstationen eingerichtet, die natürlich erst allmählich nennenswerte Mengen hochwertigen Saatgutes aus eigener züchterischer Arbeit liefern können. Um aber möglichst bald schon im Lande gezogenes reines Saatgut zu bekommen, wurde eine Saatprüfung und Saatanerkennung auf Privatpflanzungen durch Sachverständige des Gouvernements nach dem in der Heimat bewährten Muster der Deutschen Landwirtschafts-Gesellschaft eingeführt. Auf Antrag eines Privatpflanzers wird die Saat erst auf dem Felde geprüft und nach der Ernte nochmals sorgfältigst gemustert. Dann erst wird entschieden, ob sie brauchbar ist und ein Ankauf zwecks Verteilung an die Eingeborenen erfolgen soll. Man hofft, im Jahre 1914 erstmalig den gesamten Saatbedarf im Schutzgebeit selbst decken zu können.

Die Regierung arbeitet ferner darauf hin, in jedem Bezirk von den Eingeborenen nur eine einzige Sorte anpflanzen zu lassen und zwar wird diese Sorte von dem Bezirksamt nach Anhörung der Pflanzer bestimmt, damit die von den Eingeborenen gebaute Baumwolle von den Pflanzern aufgekauft und mit der ihrigen zusammen verwertet werden kann. Früher wurden die verschiedensten Sorten in einem Bezirk gebaut, wahllos zusammengekauft und verpackt. Die Folge davon war ein niedriger Preis auf dem heimischen Markte, denn die Bewertung fand nach der geringsten Sorte, die dabei war, statt.

Ganz besondere Aufmerksamkeit wird seitens der Regierung der Erkennung und Bekämpfung von Krankheiten und Schädlingen der Baumwolle geschenkt. Leider hat die Baumwolle in Ostafrika noch sehr unter solchen zu leiden und einzelne Pflanzungen haben sich dadurch veranlasst gesehen, den Baumwollbau ganz aufzugeben. Dass auch auf guten Baumwollböden die Krankheiten und Schädlinge an vielen Orten zunehmen, hat seinen Grund darin, dass sich der Baumwollbau in

Ostafrika einstweilen noch im Versuchsstadium befindet und es bei der Kürze desselben bislang noch nicht möglich war, die für die einzelnen Anbaugebiete geeigneten schädlings- und krankheitsfesten Sorten, insbesondere solche, mit kurzer Vegetationsdauer, ausfindig zu machen, bezw. zu züchten. Die Beschaffung solch widerstandsfähiger, den örtlichen Bedingungen angepasster Sorten ist das wirksamste Mittel zur Sicherung guter Ernten und wird von den Versuchsstationen der Regierung angestrebt.

Die Bekämpfung von Viehseuchen, die für die Einführung der Pflugkultur von Bedeutung ist, hat durch Mehreinstellung von tierärztlichen Personal Fortschritte gemacht.

Für alle diese gemeinnützigen Arbeiten sind aber Zeit, Geld und ein besonders tüchtiges Personal notwendig.

An Kosten dafür sind in den Jahren 1900 bis 1913 einschliesslich 2¾ Millionen Mark seitens des Kolonial-Wirtschaftlichen Komitees und 1⅓ Million Mark seitens der Regierung, im ganzen also über 4 Millionen Mark aufgewendet worden.

Natürlich kann man noch nicht auf den Tag voraussagen, wann unsere Kolonien in der Lage sein werden, nennenswerte Quantitäten Baumwolle zu liefern. Es sind noch gar viele Schwierigkeiten zu überwinden. Bei dem Mangel jeglicher Vorbilder und Erfahrungen aus dem tropischen Afrika mussten auch in den deutschen Kolonien zunächst ganz systematisch exakte Vorarbeiten ausgeführt werden, um die einzelnen Gebiete auf ihre technischen Grundlagen hin zu prüfen und das bedeutet eine Zeit und Geduld erfordernde schwere Arbeit. Wir befinden uns eben noch mitten in der Periode der Experimente, bei denen einzelne Fehlschläge, wie bei allen Versuchen ähnlicher Art, unvermeidlich sind, während die erzielten Resultate, auf grösseren Anbauflächen nutzbar gemacht, erst allmählich in Erscheinung treten können. Jedenfalls hat man bereits einigermassen die Richtlinien festgestellt, wie die Produktion verfolgt werden muss und man weiss mancherorts mit einiger Sicherheit, wie man es nicht machen soll und auch das ist schon etwas wert.

Die Vorbedingungen für einen lohnenden Baumwollbau in unseren Kolonien sind vorhanden. Es handelt sich jetzt darum, das für die Frage in weiten Kreisen erweckte Interesse in die richtigen praktischen Bahnen zu lenken und dabei wird das staatliche Versuchswesen die wertvollste Mithülfe leisten.

## LA CULTURE EXPÉRIMENTALE DU COTON ÉGYPTIEN EN GRÈCE.

Par C. Phoca Cosmetato.

Depuis quelques années le Gouvernement Hellénique a fait de grands efforts pour favoriser en Grèce la culture expérimentale du coton egyptien, tant parmi les différentes stations agronomiques que parmi les Sociétés d'Agriculture et les particuliers.

Etant donné le climat doux de la partie du royaume qui est limitée par la frontière qu'avait la Grèce avant la guerre, cette culture est appelée à prendre une grande extension dans cette région.

Si en effet cette plante ne se montre pas très exigeante sur la nature du sol, elle est au contraire très facilement impressionnée par les conditions climatériques.

En général les conditions météorologiques de la Grèce sont très favorables à la culture du coton, excepté dans les régions particulièrement froides, à exposition nord.

Par contre dans les régions abritées nous trouvons un ensemble des conditions atmosphériques qui sont éminemment proprice à la culture de cette plante.

L'hiver étant très doux et relativement de courte durée nous pouvons exécuter nos semailles de bonne heure, vers le commencement du mois de mars, ce qui a une très grande importance pour la bonne réussite et le bon rendement de notre entreprise. D'autre part le mauvais temps et les pluies n'étant pas à craindre pendant la maturation du fruit, nous pouvons obtenir une parfaite maturation de celui-ci, ainsi qu'un rendement élevé.

L'expérimentation de cette culture a été faite un peu partout dans le royaume, aussi bien au Péloponnèse que sur la Grèce continentale.

Les résultats des expériences que je citerai tout à l'heure sont ceux obtenus jusqu'à 1912, l'année dernière les troubles politiques n'ayant pas permis l'exécution d'aucune expérience.

Je vous parlerai tout d'abord des résultats obtenus au Péloponnèse, et je vous citerai en premier lieu les expériences faites par la Société d'Agriculture de Githion.

Cette Société, après avoir expérimenté pendant plusieurs années la culture du coton, se déclare très satisfaite des résultats obtenus jusqu'àujourd'hui. Comme condition essentielle du succès, elle attire l'attention du Service Agricole sur la nécessité qu'il y a à faire les semailles de bonne heure après une bonne préparation du terrain, vers le commencement du mois de mars, et pas plus tard que les derniers jours de ce même mois. L'écimage ici n'a pas donné de bons résultats. Par contre les binages ont donnés de très bons résultats, et les parcelles de terre binées trois ou quatre fois présentaient une différence très marquée de végétation avec celles binées seulement une ou deux fois.

La culture du coton a été faite sur du terrain non irrigable, et en général le rendement sur les terres de richesse moyenne, et se désséchant relativement en été, a été de 700 à 1,025 kilos de coton par hectare, et de 1,150 à 1,300 kilos par hectare pour les terres riches et conservant en été une assez grande humidité.

La surface totale cultivée par la Société de Githion a été de 30 hectares.

D'autres expériences ont été faites encore au Péloponnèse, et partout les résultats ont été encourageants. En Messinie par exemple sur les terrains à sous-sol humide on a obtenu avec la variété de coton Sakellaridis 1,700 kilos de coton par hectare.

Les expériences faites sur la Grèce continentale ne sont pas moins satisfaisantes.

La Station Agronomique de Messolonghi a expérimentée sur une assez grande surface irriguable la culture du coton avec la variété Sakellaridis. Malgré l'époque retardée à laquelle on a fait les semailles, vers le commencement du mois d'avril, et malgré les chaleurs d'été qui en ont suivi, le thermomètre ayant atteint 39° et 40° C., le rendement a été encore rémunérateur, puisqu'il a atteint 900 kilos de coton par hectare.

Comme culture d'entretien, on a donné un premier binage vingt jours après l'apparition des plantes, et plus tard après avoir éclairci ceux-ci on a donné un second binage, et après quelques jours on a arrosé pour la première fois. Jusqu'à la floraison on a continué a arroser et à biner tous les vingt jours, époque à laquelle on a suspendu tout arrosage. Mais comme je l'ai déjà dit plus haut, l'été ayant été particulièrement chaud, on a été obligé de recommencer les arrosages en août ce qui a eu une mauvaise influence sur la maturation du fruit, puisque celle-ci a été assez retardée.

En général la maturation du coton en Messolonghi et les environs est parfaite, à condition d'executer les semailles de bonne heure.

D'autre part, étant donné la grande surface de terre pouvant être irriguée dans cette region, environ 5,000 hectares, cette culture est appelée à prendre une grande extension.

Des expériences ont été également faites, sous le ciel bleu de l'Attique, dans le Département de Livadia. Ici les semailles ont été faites tantôt de bonne heure vers le mois de mars, tantôt tardivement vers le mi-mai. Tous les expérimentateurs n'ont pas préparé le terrain de la même façon et des résultats satisfaisants en rendement ont été seulement enregistrés, chez ceux des agriculteurs qui ont fait plusieurs labours en automne, et qui ont effectué les semailles de bonne heure.

Dans ce même département il a été aussi démontré que les labours profonds d'hiver étaient d'une nécessité impérieuse, pour la bonne réussite de cette culture.

Enfin en Thessalie on a cultivé différentes variétés de coton, non seulement en vue d'obtenir des résultats au point de vue du rendement, mais aussi pour savoir quelles sont les variétés qui mûrissent le plus vite. Ainsi on a expérimenté avec les variétés suivantes.

1° variété Sakellaridis.
2° ,, Voltos.
3° ,, Afifi.
4° ,, Nubari.

Les semailles ont été effectués en mi-mars et les variétés Sakellaridis et Voltos sont arrivés en maturation un mois à peu près avant les deux autres.

Au point de vue du rendement on a obtenu par hectare avec les variétés déjà citées : —

| | | | | |
|---|---|---|---|---|
| 1° variété | Sakellaridis | 800 | kilos | par hectare. |
| 2° ,, | Voltos ... | 900 | ,, | ,, |
| 3° ,, | Afifi ... | 950 | ,, | ,, |
| 4° ,, | Nubari ... | 800 | ,, | ,, |

Il ne faut pas oublier que ces résultats ont été obtenus sur du terrain non irriguable.

Dans aucune des expériences précitées il n'a été fait usage d'engrais, le but de l'expérimentateur étant de déterminer dans quelle mesure les différents sols sur lesquels on a tenté la culture expérimentale du coton se prêtaient à celle-ci, avec la valeur de leur fertilité intrinsèque.

On n'a pas eu à signaler l'apparition d'aucune sorte de maladie de la plante, qui dans d'autres pays cause de grandes pertes.

Les dépenses de la culture du coton varient généralement suivant la nature du terrain, et le nombre des façons aratoires données, entre 150 fr. à 300 fr. par hectare.

Le Gouvernement Hellénique, soucieux de savoir exactement quelle était la valeur du coton récolté, sur les différentes régions du royaume, tant au point de vue de sa qualité qu'au point de vue de sa valeur marchande, a envoyé des échantillons en Egypte à la maison bien connue de MM. Coremi et Benachi avec la prière de déterminer la qualité à laquelle il fallait classer chaque échantillon, ainsi que sa valeur marchande.

La réponse de la maison de MM. Coremi et Benachi a été tout à fait satisfaisante. Après avoir examiné attentivement les différents échantillons, elle a déclaré que le coton provenant de la région de Githion était de toute première qualité, et en tant comparable avec les meilleurs cotons egyptiens. Comme valeur marchande cette même maison a proposé d'acheter tout le coton produit dans ce district, au prix de 22 écus le cantare égyptien.

Le coton de Messinie a été estimé à 21 écus le cantare.

Le coton produit à Messolonghi, a été estimé à 21 écus le cantare.

Le coton d'Attique a été trouvé un peu inférieur comme qualité des précédents, et il a été estimé à 16 écus le cantare.

Enfin le coton de Thessalie fut trouvé de bonne qualité et son prix estimé entre 20 à 22 écus le cantare.

Le commerce de ce nouveau produit agricole n'étant pas encore développé dans le royaume, des intermédiaires peu scrupuleux ayant essayé de profiter de l'ignorance des paysans pour leur acheter leur récolte de coton à des prix dérisoires, le Gouvernement a cru devoir intervenir, afin d'éviter tout découragement qui pouvait en résulter pour la culture de cette plante.

En effet une loi veint d'être votée d'après laquelle le Ministère de l'Agriculture peut acheter pendant quelques années à un prix qu'on fixe annuellement toute quantité de coton qui dans son pays d'origine n'aurait pas pu être écoulée au prix moyen du marché.

Comme les résultats obtenus jusqu'aujourd'hui sont fort encourageants pour cette nouvelle culture, cette année on a fait des expériences sur une plus grande échelle, et on espère que quand dans quelques années la période expérimentale sera définitivement close, on pourra produire en Grèce suffisamment du coton non seulement pour la consommation locale, mais aussi pour en exporter.

## THE IMPROVEMENT OF COTTON BY SELECTION.

By J. Stewart J. McCall, P.A.S.I., C.D.A.Glas.
*Director of Agriculture, Nyasaland.*

During the last few years the habits of the cotton plant have been closely studied in Africa, but much work remains to be done before African cotton fields, like those of America and Egypt, will contribute their normal returns to the commerce of the world.

At the commencement of the British cotton movement, which is intimately connected with the foundation of the British Cotton Growing Association in 1902, there were no reliable experiments nor knowledge of what types of cotton were likely to succeed in Africa, the dominating factor of the movement being the necessity of broadening the basis of supply and supplementing the American crop, which promised to be unable to cope with the ever-increasing demands of the world.

From 1904 cotton growing has received a large share of attention from the Government Agricultural Departments, and in not a few instances officers with special knowledge of the crop have been appointed, and, through their co-operation with the British Cotton Growing Association, considerable native and European industries have been established on sound business lines in the Colonies and Protectorates of East and West Africa.

In the initial stages of an industry, whose rapid development is of considerable importance, there is little time for the cotton expert to settle down at headquarters and carry out careful scientific selection; his services are always in demand at all points of the compass, instructing planters, distributing seed to natives, and advising *re* a thousand and one problems connected with cotton, but such travelling and work are necessary before he is competent to settle down and select what is required for the country of his adoption.

This question of cotton selection has to be finally settled, or the Protectorate or Colony, as the case may be, will never establish itself as a reliable source of cotton, especially where the main cultivators are uneducated natives.

The great aim is to get a standard type of cotton, or, within broad lines, one of the following three types:—

(1) Egyptian.
(2) Long staple Upland.
(3) Short staple Upland.

In order to do this the first necessity is to control the seed, and the best key to such control is the Customs ports of entry, and a Proclamation or Rule under a Cotton Ordinance making it impossible for private individuals to import seed unless approved by the agricultural authority is the surest way to attain this standard.

There is nothing more harmful to the cotton industry of any new country than the uncontrolled promiscuous importation of all classes of seed by private individuals, and nearly every new centre of production learned the necessity of such control only when the mixed staples of their exports were pronounced as practically unsaleable, and then large quantities of seed had to be destroyed and a fresh start made with pure seed.

Before proceeding, the writer would like to make it clearly understood that the mixed staple above referred to is largely due to seed-mixing at the ginnery and not to cross-fertilization, and investigations in Nyasaland point to a very low percentage of cross-fertilization in cotton as compared with most other farm crops; in fact, in many cases, in warm, dry districts, a considerable percentage of the flowers are fertilized before the buds open, and there is very little inter-flower visitation by honey bees.

### Selection of Variety.

The variety to aim at is the one which is most suitable for the country, gives the heaviest yield per acre, and the most valuable staple; the determining factors are generally climatic.

It is well known that, apart from Sea Island, Egyptian varieties produce the highest valued staples, and naturally in many instances they have been the first tested in new centres of production.

The experiences of Nyasaland with Egyptian cotton have been most disappointing, and it has now been proved for all time that it is impossible to cultivate Egyptian cotton with any degree of success at elevations over 1,000 ft.; and further, on account of the general infection of bacterial blight throughout the heavier soils of the Shiré valley, the only place where Egyptian cotton can be profitably grown is on limited areas of light soil in the Lower Shiré and Ruo Districts; and for these reasons Egyptian cotton gives little indication of ever becoming an extensive cultivation in Nyasaland.

Of the two remaining types, viz., long staple Upland and short staple Upland, the former has given such good results that experiments with the latter have been discarded; and in the progeny of the American long staple variety "Floradora," originally imported some ten years ago, and now thoroughly acclimatized, we have an excellent type of cotton known as Nyasaland Upland, and when grown from carefully selected seed produces fibre which, in years of small Egyptian crops, can be used for mixing with Abassi; and, in years of plentiful Egyptian cotton is easily absorbed by the fine spinners and velvet manufacturers at a remunerative premium of 2d. to 2½d. on Middling American, or in round figures 8d. to 9d. per lb. (1s. to 1s. 2½d. per lb. was paid for choice consignments when Egyptian cotton was scarce in 1909-10).

In 1909 the brokers reported that they considered Nyasaland Upland to be the finest cotton ever grown from Upland seed and imported into Liverpool from America or anywhere else, and, immediately on receiving this report, the writer induced Sir Alfred Sharpe (then Governor) to issue a Proclamation stopping the importation of seed from America, and since 1910 no Upland seed other than that imported by the Director of Agriculture for experiment has been allowed entry to the Protectorate, and we have now a uniform type of cotton and no further complaints regarding mixed staples.

## Comparison with Original Stock and Value of Acclimatization.

In 1912 the writer imported through the United States Department of Agriculture some pure "Floradora" seed from American stock to compare it with Nyasaland Upland, and when this seed was grown under exactly similar conditions on the Government farm the plants from the freshly imported seed were noticeable for their excessive luxuriance as compared with Nyasaland Upland (late "Floradora"). The leaves and bracteoles of the Nyasaland Upland had decreased in size by at least one-third, the staple from the imported seed was similar in length and strength, but had not assumed the same degree of lustre and silkiness which seem to be an acquired characteristic of all cotton grown for a few years in the Shiré Highlands, this feature being previously recorded in connection with many short staple variety tests conducted during the last five years; and lastly, the yield from the newly imported seed did not compare favourably with the established local variety.

## Climatic Factors and Soil Factors affecting Quality of Staple.

In Nyasaland, cotton is grown at all elevations from 200 to 3,200 ft. above sea-level, and on soils varying from sand to heavy red clay; under such conditions it is not surprising that there is a large variation in quality of staple, and a study of their influences on the cotton plant is necessary before proceeding with direct selection.

The Government of Nyasaland have two farms, one situated at Namiwawa, Zomba, at an elevation of 2,300 ft. approximately, and the other at Nyachiperi, Lower Shiré, at an elevation of 200 ft. At both centres cotton selection has been carried out for four years on a combined area of from 500 to 600 acres per annum, and among others the following deductions have been arrived at with regard to the effect of elevation, soil, and heat on long staple Upland cotton in Nyasaland:—

(1) Upland cottons grown at elevations under 800 ft.

are inclined to degenerate and produce a harsh short staple.

(2) Upland cottons grown at elevations over 2,500 ft. produce the longest and silkiest staple, but, unfortunately, the weakest.

(3) Upland cottons grown at elevations of 1,700 to 2,700 ft. produce the most satisfactory crops both in quality and yield.

(4) Light sandy soils produce small plants with short harsh staple, but encourage early maturity.

(5) Heavy clay soils produce large plants with superior lint, but delay maturity.

(6) Prolonged heat at daily shade temperature of 100° to 115° F., when accompanied by drought, tends to the production of short harsh staple.

(7) Periods at which the thermometer stands below 60° F. during the ripening season have a distinct tendency towards the production of weak staple.

The writer does not contend that the above facts are strictly applicable to all cotton-growing countries, but their consideration is worthy of careful examination as a general guide to selection, and also demonstrates the necessity of encouraging planters to select for the special peculiarities of their own plantations, using as a basis approved seed which has been originally selected by Government and proved as suitable in general for the conditions of the country.

### Plant Characters worthy of Consideration.

#### (a) *Flower and Fruit.*

The perfect development of the flower and fruit largely determines the yield of any variety, and in this respect cotton varies exceedingly, some plants having the unfortunate habit of shedding the squares, the flowers, or the bolls, and such conditions can be largely remedied by selection.

One of the most noticeable features in a field of unselected Nyasaland Upland cotton is the large percentage of practically boll-less plants, and during propagation and multiplication from individual selections the writer had to discard a very large number of families for this defect, and for this reason alone it is a wise precaution not to commence selecting foundation plants until the crop is approaching harvest.

Boll-shedding is largely avoided by selection, and at the time of writing there is 150 acres of a selection of Nyasaland Upland known as No. 56 on the Government farms which for four years has proved itself under varying conditions to be remarkably free from this defect. It may be of interest to mention that the red shoe flower (*Hibiscus rosa sinensis*) produces numerous flowers in Nyasaland, but never sets its fruit, and the writer is inclined to the opinion that certain cottons have this objectionable character developed in varying degrees, apart from the effect of adverse climatic conditions which for many years have been recognized as the more or less direct cause.

The shape of the boll has a good deal to do with the quality of the lint, as undoubtedly the cotton from distinctly pointed bolls is longer than that from short, round bolls of the strictly Upland type.

In the Report of the Agricultural Department for 1910, reference was made to possible hereditary characters in respect of strength and length of staple, but investigations extending over the last four years with cotton selections from the same individual plants grown in varying conditions and elevations point to the fact that such desirable qualities are very largely affected by soil, climate, and rainfall, and cotton with $1\frac{3}{16}$ in. staple, and described as strong and silky, when transferred to lower and more tropical regions of the Shiré Valley with deficient rainfall, degenerates in a single season to a staple of 1 to $1\frac{1}{8}$ in. and the fibres lose a large degree of their strength and lustre; one is therefore forced to the conclusion that the real benefits of selection can only be obtained by selecting for local conditions, and that there is little value in selecting at elevations over 2,000 ft. to improve the characters of a crop to be cultivated on a commercial scale at elevations below 500 ft.

The best results with Upland cotton at Nyachiperi Farm have been obtained with selected "Griffin" cotton.

This cotton for two years was cultivated on a seed plot in the Shiré Highlands, but proved too delicate and susceptible to cold.

During the last three years this cotton has been selected and grown at the lower river farm, and promises to retain its lustre and quality in a greater degree than ordinary Nyasaland Upland, and the yield per acre in 1913 was 149 lb. of lint, as against 113 lb. with Nyasaland Upland, both being valued at 8d. per lb.; the gross value per acre was £4 19s. 4d. for "Griffin" and £3 15s. 4d. for Nyasaland Upland; "Griffin" cotton is certainly worthy of attention as a long staple variety for hot, dry districts with elevations not over 500 ft.

### (*b*) *Leaf and Stem.*

Uniformity of vegetative characters has a distinct bearing on the economical spacing of any crop, and a very direct bearing on cropping results of sun-loving crops, such as cotton.

There is a close connection between maturity and vegetative habit, the small and less leafy plants generally maturing several weeks before the large and leafy types, and although growth is strongly affected by food supply, and particularly by the amount of soluble nitrogen, there is every possibility of reducing excessive vegetation by selection.

The branching character of the type has a great influence on the ripening of the crop, and under short season conditions it is necessary to take advantage of every character that leads to early maturity, as heaviest yields are obtained from plants which carry many fruiting laterals, arranged around the main stem in such a manner as to allow the maximum amount of sunshine to reach the entire plant without shading its neighbours or obstructing tillage operations for the best growth of the crop.

Plants with extra long horizontal or prostrate lower limbs should be avoided, as they interfere with cultivation, and the cotton in the opening bolls of such limbs is always depreciated through soil stain, and plants with dense top growth should never be selected for Highland cultivation, as they stimulate boll-shedding, favour boll anthracnose, and delay harvest.

The writer greatly favours the small type of cotton bush for Highland cultivation for the following reasons:—

(*a*) They mature early.

(*b*) They reduce cover for boll worm and cotton stainers.

(*c*) They are never cast by storms.

(*d*) They are never so severely attacked by cotton aphis.

(*e*) They do not favour the spread of anthracnose.

It will be found that once a type is carefully selected from pure acclimatized seed the branching character remains constant in the offspring of Upland cottons; this is borne out in many varieties of Upland cotton, one of the most marked examples being "Jackson's limbless." Egyptian varieties, however, are very unstable under new conditions, and the decrease in the crops obtained from Egyptian seed which has been grown in Nyasaland for a few years, as compared with those obtained from seed freshly imported from Egypt, is largely due to the increasing percentage of tall, imperfectly branched plants; in the absence of careful systematic selection for type, the writer always recommends the use of freshly imported Egyptian seed.

### System of Selection Recommended.

*First year in field.*

(1) Sow the best seed procurable of the variety under selection.

(2) Commence selecting individual plants a few weeks before harvest, paying special attention to the points discussed under "Plant Characters worthy of Consideration."

(3) Mark each plant separately, harvest separately, and place the seed-cotton into bags attached to each plant.

*First year in laboratory.*

(1) Discard all bags with weak staple.

(2) Discard all bags with staple less than $1\frac{3}{16}$ in. (long staple Upland).

(3) Determine lint percentage, and discard all samples under 30 per cent. lint.

(4) Favour silkiness and lustre, and discard for dulness and harshness of lint.

(5) From all approved bags which have passed the above tests, envelope samples of lint numbered to correspond with field number should be filed for future comparison.

*Second year in field.*

(1) Sow the seed from each bag in separate ridges arranged according to lint percentage.

(2) Make notes regarding germination, general progress, and maturity.

(3) Uproot before flowering all lines which show no fixity of type, appear sensitive and unsuited to climatic conditions, or are specially subject to disease, also delete number from Register.

(4) Harvest each line separately, and mark bag with number to correspond with sample in laboratory.

*Second year in laboratory.*

(1) Compare average samples from bags, with numbered samples of previous year.

(2) Re-test for lint percentage, and discard under 30, or for any other undesirable character, such as irregularity, shortness, or weakness of staple.

(3) Take further samples for reference, give same number as in first year, but place it over 2 to indicate second year's crop.

*Third year in field.*

(1) Sow seed from each number separately in acre plots, using the seed carefully, in order to grow if possible a plant from every seed and so expedite multiplication.

(2) Uproot undesirable plants if in minority; if in majority, discard the whole acre.

(3) Harvest each acre separately.

*Third year in laboratory.*

(1) Repeat tests of first and second years.

(2) Submit 7 lb. samples for brokers' report through the Imperial Institute.

*Fourth year in field.*

Plant 10 to 20 acre blocks with the finest selections. and when harvested compare yield and calculate comparative return on crop valuation, keeping as the foundation for all future selection and seed distribution the progeny of the two most profitable families.

In conclusion, it is recommended that the experimenter use greater care in making his initial selections, as the highest standard of perfection can only be attained by careful work and multiplication from the individual plant; but in order to use a hard hand in roguing it is well to start with not less than 500 carefully selected plants, as they rapidly decrease in the first two years.

The system of selection discussed in this paper is no doubt open to many theoretical objections, but it is sufficient for the writer that it can be largely employed at little expense by the intelligent planter, and even in a modified form has given most excellent results in Nyasaland.

It may be of interest to mention that the whole of the native cotton in the Mlanje District of Nyasaland during the current year is the progeny of two plants first selected in 1909, and multiplied on the Government Farm, Namiwawa, to the extent of 160 acres, and then further multiplied by the villagers of two native chiefs, the cotton being purchased by the British Cotton Growing Association and the seed kept separate in sufficient quantity to stock this district, which in a normal season produces 200 tons of cotton.

The value of a working system of seed selection in cotton has been amply demonstrated in the improved yield and prices obtained in Nyasaland, and the continuance of a Government seed farm is a necessary adjunct to the native cotton industry.

## COMMERCE AND SCIENCE IN COTTON GROWING.

By J. W. McConnell.

*Vice-Chairman of the Fine Cotton Spinners' and Doublers' Association.*

The primary object of this paper is to put before the Congress some thoughts in regard to the objective which should be aimed at by cotton breeders and cotton growers. I propose to elaborate a letter on the same subject which I wrote to *The Textile Mercury* in March, 1914. In writing that letter I only had in view cottons suitable for fine yarns; but I think the same considerations are pertinent, at least to some extent, to the growing of all cottons. It may be that in the United States of America cotton has been grown hitherto so as to give fairly satisfactory results to the grower without any very particular attention being given to scientific considerations. So far as this is the case, it is due to the fact that cotton growing in America is an inherited industry. For over a hundred years—practically for the whole period of commercial cotton spinning—America has been in the position of supplying the standard cottons of the trade. It is probably more true to say that cotton spinning has been elaborated so as to handle in the best possible way the cotton from America, than to claim that America has evolved cotton specially suitable for spinners.

But whatever may be the truth about America, there can be no question that in other countries success in cotton growing can only be obtained by the application of scientific principles. India affords an object-lesson of a sad kind. There, there is a great industry, in the sense that millions of acres of land are employed; great, again, in the sense that millions of people work at it; great, again, in the sense that it is an ancient industry with a great historic past. In every other sense it is a sadly little industry. It produces a pitifully small quantity of indifferent quality. Scientific principles have been ignored in the past. It is to be hoped that the new efforts now being made will produce good results, but I fear that the Government are still very far from recognizing that liberal expenditure on scientific work in cotton growing and in agriculture generally is the only foundation on which prosperity for India can be built. The stoiy of cotton in Egypt is happier, but it teaches the same lesson. Apparently its early successes were largely due to the strong hand of Mohammed Ali compelling the use of the best seed and the best methods of growing known in his day. And subsequently I think that Egyptian cottons have just maintained a balance between the tendencies of Nature to deteriorate and the efforts of human agents to improve.

In the newer cotton growing countries—which, as it happens, are nearly all in the tropics, and thus directly connected with this Congress—I am sure that success depends entirely on the application of the best scientific learning to what is necessarily a very difficult problem.

The difficulty of growing good cotton is due to several causes. First of all there is no natural cotton that is good. All its good qualities have to be given to it by human agency; or, at least, have to be caught and kept by human agents whenever Nature chances to give something good. Otherwise Nature will hurriedly destroy the good characteristic. But on the other side there is the curious difficulty of knowing what is good. Cotton is not a food or drink, whose merits can be appreciated by the grower himself. Cotton, again, is not capable of valuation by chemical analysis. Nor can it be readily and easily tested for quality in its natural state. He who would grow good cotton is confronted with the difficulty of knowing what is good. The question how good qualities can be added to or increased in vegetable growths is, I suppose, in itself a problem for agronomists. But in cotton the question that has first to be settled is: What does the spinner want? And, conversely, how is the grower with a handful of new plants to judge their relative merits? Then there is the further difficulty that the spinner can only answer the question very imperfectly. A spinner is not necessarily a scientist. In all the century and a quarter during which the cotton trade has grown to greatness it would have been nearly useless for the spinner to spend time in studying the laws that govern quality in cotton. Useless because he knew no one who would have tried to give the special characteristics required. The actual sequence of events, I think, has largely been that the grower has grown what chanced to grow, and the spinner has adapted his machinery to deal with it. And by the rule of thumb the spinner has bought what suited him the best, and the grower has used the seed which promised the best results to himself.

At the present time things are different. In every country where it has been sought to introduce cotton as a new product its difficulties have compelled people to study its nature, and it is largely owing to the Agricultural Departments that so much progress in this knowledge has recently been made. Again, the organization of the Imperial Institute, and the formation of the technological departments in our municipalities, and at the Universities, have made possible research work in the nature of the fibre. In the United States some interesting experiments are being made with the object of ascertaining the practical differences to the mill arising from the use of cottons of different grades, these grades being classified under the new official standards. I may quote some useful words from *Bulletin* No. 62, U.S. Department of Agriculture, which reports progress so far made. Mr. N. A. Cobb says therein: "The Official Grades at present take cognizance of only two qualities, viz.: (1) The colour; and (2) the amount of trash and waste matter. Any complete system of standardization of cotton will, however, have to take into consideration, among other things: (3) the length of the fibre; (4) the strength of the fibre; (5) the clinging qualities of the fibre; and (6) the bleaching qualities of the fibre."

This is aiming high; it is indeed a fine ideal, and the business of the spinner will be simplified and the products of the mill improved if the time ever comes that official valuations take properly into consideration the spinning merits of cotton as apart from its mere appearance. Mr.

Cobb's list of qualities is good. Except for two omissions it seems practically to cover what a spinner is looking for.

(1) Colour is important in many cases. There are occasionally sold articles of wear in which the dead white of American Upland or the pearly white of Abassi are required; there are others which make their market by their natural brown; but, as a rule, the value of colour to a spinner is that his customers consider it an index of quality; if he changes the colour or shade of his cotton his customers are suspicious that the quality of the yarn has also been changed. I think, also, that to cotton growers colour may very probably be of great value as an index of purity or of trueness to type.

(2) Amount of trash and waste. This is of the first importance commercially. Mr. Cobb says that the mill experiments with cottons of the various official standards show visible waste, varying from 4 per cent. in Middling Fair to about 11 per cent. in Good Ordinary. If this be confirmed by the fuller report, which is promised later, it shows the question of waste to be an even more important one to the general bulk of spinners than I should have expected. I know its great importance to fine spinners. But on the figures given it means that if Middling Fair is worth 8d. per lb. containing 4 per cent. of waste, then Good Ordinary will cost the spinner as much if he pays 7·42d. for it. Of course, in addition, the yarn made from the poorer cotton will still be poorer, even when this extra percentage of waste has been removed. Mr. Cobb speaks only of visible waste. Invisible waste, which may consist of damp, whether natural or fraudulent, or of dust, is equally important. I may mention a new cotton I once tried. It was attractive in appearance, but the fibres broke up into dust to such an extent that it was almost impossible to make a yarn at all, and quite impossible to make a yarn of the same counts, *i.e.*, of the same thickness, as usual.

This question of waste is one for scientific breeders. Waste may be trash, due to the leaf or to the shape of the boll. Waste may be immature fibres, due to the fibre formation on the seed, which, I am told, is an inherited quality. There may be other inherited causes.

Or irregular fibres may be due to irregular plant food. Nature unaided will give us little but waste. It is to human science that we look for good cotton.

(3), (4), (5) Length of fibre, strength of fibre, and clinging qualities. Mr. Cobb rather curiously omits fineness. Cotton yarns vary in value according to their cleanliness, which is affected by the amount and kind of waste. They also vary in value according to their fineness, their strength, and their regularity. These qualities of fineness, strength, and regularity in yarns depend primarily on the cotton. Cotton, therefore, is valuable to a spinner in proportion as it gives him these qualities in his yarns. Now I imagine that these qualities in yarns come from length and strength and fineness of fibre, and from some other qualities which Mr. Cobb calls clinging qualities. The well-known convolutions no doubt affect this clinging, and probably also some characteristics of the nature of flexibility of skin not easy to ascertain or define. A spinner sometimes speaks of them as oiliness. I think that no one knows what are the exact relations between these characteristics in the fibre and the qualities we desire for our yarns. There is, I am sure, room for research work on this point. There is also urgent necessity for corresponding research work by cotton-growing scientists as to the means by which they are to produce those qualities in cotton which the textile laboratory finds to give the required results in yarn.

Now I pass from the spinner's requirements to a matter which concerns both him and the grower, and that is, that cotton should be cheap. The American orator proclaims "Cotton is king." True, but it is a limited monarchy. To remain king, cotton must be popular, cotton must be cheap. Cheapness does not mean want of proper profit for the grower. It does mean that all the resources of science must be employed to produce large crops per acre. Suitable cultivation must be given, suitable manures must be employed; but, above all, it rests with the plant breeder to evolve a cotton plant whose purpose in life is to make cotton, and not wood or cotton seed. The plant must also be energetic and ripen its fibre quickly, so that men and not the insects can get it. There is no necessary conflict in cotton between quality and quantity. The Sakellaridis cotton in Egypt, the Cambodia in India, have proved that it is possible at the same time to make cotton more valuable to a spinner and at the same time more prolific, and therefore less expensive, to the grower. Here, then, is another objective for the cotton-growing scientist. I suppose—though I do not actually know—that in each country some obscure laws of climate and soil eventually prescribe what cottons can be grown prolifically. It is for the individual planter and for the Agricultural Department of each Government to ascertain within these limits what kind of cotton will give the greatest monetary return. This is roughly the product of the two factors, quantity of lint production multiplied by price obtainable. The relative price obtainable for any cotton as compared with others which might be grown is necessarily variable. It varies partly as the world's needs alter. It varies still more as the quantity produced increases or decreases. Sakellaridis has spoilt its price by its own productivity. But it will still be grown in Egypt because it pays the grower even at the lower price. And in a few years, if its excellence is preserved, it will regain its price, because the spinners who once use it can never go back to a poorer cotton.

I suggest here, as a broad rule for every country and for every plantation, that it is bad business to grow cotton of small value per pound instead of higher-priced cotton, unless the cheaper cotton is so prolific that its extra quantity makes up for its lower price.

We can now define to some extent the questions to be answered by any paternal Government which desires its subjects to produce cotton. Some of the questions are: Can cotton be grown regularly one year after another? This depends on soil and climate. Is there labour available for growing and picking? What kinds of cotton can be grown, and therefore what price can be expected in the market? What will be the cost of carriage and merchanting? And, therefore, will the price that remains for the grower give him a reasonable return when multiplied by the quantity he can grow? Will it pay him as well as other crops possible to be grown?

For more advanced communities the questions which arise are easy to state but exceedingly difficult to answer. Two questions cover the whole field; they are: How can the cottons grown be so improved as to be worth more money? and, How can they be made more prolific so that the results of growing them will be better for the grower?

The answers to both questions lie in the sphere of thought which I have attempted to indicate.

But there is one quality more, not named by Mr. Cobb, and yet I think the most important of all to growers and to spinners. I refer to uniformity. In all the qualities a spinner wants in cotton, viz., fineness, strength, length, adhesiveness, colour, and freedom from waste, in each and every case uniformity is essential if the quality is to be worth money. To be partly fine is to be coarse; to be partly strong is to be weak; to be irregular in length or colour or anything else is to be so far poorer and less valuable. Also irregularity in plant habit is a certain bar to a big production. Now I believe that this virtue of uniformity, this *sine quâ non*, without which no goodness is good, I believe that this is now, for the first time in the history of cotton, within reach of attainment. Uniformity can only be hoped for from plants which will breed pure. A pure plant may conceivably fail in uniformity, but without purity uniformity is inconceivable. Now it is well known to all students of cotton growing that the work of Mr. Lawrence Balls in Egypt, and of others elsewhere, has shown that it is possible to cultivate cotton on a commercial scale from pure parents. There is a good deal of evidence that purity in itself gives value to cotton. The best practical cotton growers of my acquaintance attach the first importance to purity, even where they have not hit on Mr. Balls's system of securing it. The experiments of the Americans with Egyptian seed in Arizona bear a curious testimony to this principle. So long as they used imported seed the results were poor. But by selection or by accident they struck on an indigenous offshoot from the original Mitafifi. Some of the cotton from this is as much superior to the best

Sakellaridis as that is superior to anything else in Egypt. They were not working on Mr. Balls's system, and in practice the commercial crop from this cotton is too mixed to be of any great value. But the testimony to the value of purity lies in the description of his experiments given by Mr. Kearney. Year after year he comments on the prepotency of his new cotton, and on its resistance to hybridization. It is evident that Nature was here making one of her rare efforts to produce a pure cotton, and that, so far as she succeeded, she was producing something exceptionally good.

But the most striking evidence of the value of purity is to be found in the mill tests of Mr. Balls's own cottons. Four samples of pure strains were selected for examination. The finger test of Alexandrian valuers found one to be good, the others indifferent. I may admit that the judgment of practical spinners was not entirely at variance with this, but the mill test was very different. Of the four samples, one represented an attempt to develop a substitute for Sea Island cotton. In the first instance it was unfortunately not tested on this basis in the mill. No exact report can be given, but the cotton was reported to be neppy and wasty, but strong. I have subsequently had a small sample put through a mill which spins only Fine Sea Island cottons. The experimental cotton proves to be very wasty, *i.e.*, to have a large excess of imperfect fibres; but when spun into yarn so fine as 188's, it is about 9 per cent. stronger than the standard of the mill, and is about equal in appearance.

The other three samples were tested against Nubari classified as "Good." This showed a loss of 18 per cent. of waste and gave a strength of 10·00 lb. One sample, which I will call A, showed 16·8 per cent. waste, and strength 12·50 lb. This I understand to be from Assili parentage and to be extraordinarily prolific. B showed 17·5 per cent. waste and strength 14·00 lb. This is the cotton that was approved in Alexandria. C showed 15·7 per cent. waste and strength 16·30 lb. Considering that the comparison was made against Nubari cotton classing "Good," which is far above the average of Egyptian cotton, it must be admitted that these are remarkable results. The waste in each case is less and the strength much greater. It is unfortunate that the bulk of the cotton grown from these four strains was sold off before the results of our experimental tests were known. Thus there has been no opportunity of qualifying or confirming the tests on a large scale, but I may say that I have had a second test made with small samples in another mill, and again all three samples were stronger than Good Nubari; and again sample C, in which uniformity was the most noticeable characteristic, came out the strongest of the lot.

In conclusion I make two suggestions.

In the first place, I suggest that arrangements ought to made either at the Imperial Institute or in Manchester, perhaps preferably in Manchester, so that small quantities of cotton can be practically tested under conditions resembling those of an ordinary mill. In experienced hands a trustworthy test can be made with a pound weight of cotton or even less. If some such practical testing were regularly available it would greatly assist the scientific breeders and laboratory workers in cotton-growing countries, because they would not only be able to send small samples to be submitted to the test, but they would also be enabled to bring their laboratory experiments on single bolls and single fibres into closer relation with mill practice than is now possible.

Secondly, I commend to all who are practically engaged in cotton breeding or cotton growing that purity should be their principal objective. Hitherto the whole character of the plant has been a chance entanglement of qualities, and improvement a nearly insoluble problem. When pure strains become generally available the processes of improvement in quality or in quantity, or of gradual modification in any desired direction, will become possible, and growers and spinners will both be benefited.

# SUR LES OSCILLATIONS DES ATTRIBUTS HÉRÉDITAIRES ET LA RÉSULTANTE DES ÉQUILIBRES, CONSTATÉES SUR LE COTON EGYPTIEN.

Par Nicolas Parachimonas.

Contrairement aux cotons américains ou asiatiques qui montrent une certaine stabilité, les cotons égyptiens présentent des tendances irrésistibles vers la variabilité.

Les expériences m'ont démontré que les graines issues du même ou des mêmes générateurs donnent des individus différant les uns des autres, tant au point de vue botanique qu'au point de vue industriel.

Les causes en sont multiples : les conditions du milieu, telles que le climat, la nature du sol, le système de culture, les agents physiques et chimiques ; et, en général, les proportions des énergies radioactifs influencent certainement l'essor de la plante et tendent à la sortir de son orbite normale.

Cependant ces conditions semblent avoir une action lente et il leur faut longtemps pour manifester leurs effets.

A elle seule, l'action de ces facteurs ne peut pas expliquer la variabilité intense à laquelle nous assistons, à moins qu'on n'admette en même temps que la source des différentiations intéresse les tendances de l'économie intime du cotonnier égyptien qui subit les conséquences de sa sensibilité aux effets les plus subtils des influences des lois qui nous sont actuellement voilées.

Quoique voilées, ces lois révèlent, par leurs manifestations, le mécanisme intime des tendances et par la déduction on atteint une association d'idées qui peut, dans une certaine mesure, expliquer les phénomènes qui se produisent journellement.

L'agriculture égyptienne est fortement intéressée de ces revélations qui sont d'une grande portée pratique ; et si dans le cours des spéculations elles nous conduisent parfois dans le domaine de l'abstraction, elles ne manquent pas de nous accorder le bénéfice des conceptions pratiques que l'observation et l'expérience finissent par ériger en règles, règles qui sont autant d'articles du grand code de l'inconnu qui, hélas, nous entoure et nous pénètre.

Si l'on veut remonter à l'origine de la plante qui nous occupe, on doit se placer au moment où s'opèrent les merveilleux effets des affinités mystérieuses qui donnent naissance au germe, à l'embryon, qui contient dans son sein tout un monde; se placer au moment où se forme le pont à travers lequel la vie passe et se perpétue, c'est-à-dire au moment des étreintes des antherozoïdes dans le sein de l'ovule qui frissonne passivement au contact du processus du pollen qu'elle a appelé de si loin avec cette force attractive qui déconcerte les chercheurs des principes.

Dans ce moment solennel, les deux éléments, le mâle et la femelle, semblent être deux pôles, le positif et le négatif, dont le contact produit une vie nouvelle; ils semblent être ou avoir des mouvements dans un état distinct, qui se combinent, se complètent, se neutralisent, s'allient, s'influencent, se confondent, pour donner naissance à une résultante, pour se faire une orbite commune, un centre commun qui sera l'équilibre nouveau, l'être complet de la classe supérieure, capable dans son évolution de perpétuer à travers le temps et l'espace le cycle des manifestations par la succession merveilleuse des éloignements et des rapprochements des pôles d'énergie ainsi soupçonnés.

Théoriquement, les propriétés du pollen et de l'ovule étant d'une même origine, si les conditions du milieu ne viennent pas les influencer, l'œuf qui est produit de leur mariage devra contenir les mêmes propriétés que leur générateur commun, et si l'on osait réduire le mécanisme organique en une formule mécanique on pourrait dire que le nouvel organisme se développera mécaniquement tel un ressort, une spirale, qui subit les même pressions, qui contient les mêmes affinités, les mêmes mouvements centrifuges ou centripètes.

C'est là la manifestation ordinaire de l'implacable loi de l'hérédité qui conserve l'équilibre acquis des énergies qui laisse intacts les facteurs dont l'équation reste ainsi invariable.

Dans la nature, cet équilibre est souvent rompu, soit par les actions, soit par les réactions des diverses énergies intimes ou extérieures, et les parturbations qui en résultent donnent lieu soit à d'autres équations, soit à la destruction de l'organisme.

Cela peut se résumer par l'énoncé de la réductibilité des termes de toute équation organique jusqu'à la rupture de l'équilibre, et si l'on se permettait une divagation dans le domaine des hypothèses, on pourrait supposer un simple déplacement des centres des équilibres ou bien des modifications de la valeur des axes de l'orbite, sans que ces translations aient toujours pour effet d'anéantir les affinités ou de disloquer le mécanisme des énergies qui créent ou subissent ces affinités. En d'autres termes, il s'agirait de concevoir une coordination des mouvements et des vitesses de sorte que leur résultante ait des tendances centripètes nécessaires à la conservation de l'équilibre.

Pour ne pas tomber dans le domaine de la métaphysique, et pour énoncer les diverses étapes de la loi de l'hérédité, il est prudent, dans l'état actuel de nos connaissances, de retenir les trois dimensions mécaniques qui seules peuvent être représentées par des nombres.

En l'espèce, ces trois dimensions que l'on peut confondre à trois directions du mouvement sont : —

1° L'inertie, c'est-à-dire l'équilibre des activités au moment de l'observation.

2° Le recul, dû au relâchement des affinités à la perte d'énergies, au rayonnement centrifuge.

3° La propulsion, due au resserrement des affinités, à l'acquisition de nouvelles énergies, à l'accélération des vitesses.

Ces trois états ne peuvent être que les divers dégrés de la manifestation des mouvements dont la vitesse et l'envergure constituent les différenciations.

Que les énergies soient considérées comme potentielles ou comme cinétiques, peu importe, elles restent toujours dynamiques et nous imposent notre attitude envers l'étude des phénomènes.

Si l'on pouvait définer les trois états sus-dits, je crois : —

1° Que l'hérédité peut être assimilée à une manifestation de l'inertie qui semble être l'équilibre des énergies le plus stable, en d'autres termes, l'équilibre des mouvements dont la résultante a une direction et une vitesse centripète déterminées au moment de l'observation. La multiplication du cotonnier se faisant par la division, cette résultante due à l'action des mêmes facteurs se perpétue à travers le temps et l'espace selon des lois déterminées et poursuit sa direction et sa vitesse qui lui sont allouées par le mécanisme mondial, tant qu'elle n'est pas gênée dans son évolution par l'intervention d'autres activités.

2° Que l'attavisme ou l'archégonisme peut être considéré comme la rupture de l'équilibre héréditaire constaté et le retour dans les limites des équilibres préexistants. On dirait que le relâchement de l'action des énergies relativement nouvellement acquises modifie la direction ou la vitesse de la résultante des proportions et ramène le champ du développement dans les dimensions et les formes préexistantes, en suivant pas à pas ou bien en enjambant les séries récurrentes des oscillations, si infinitésimales que soient les actions contraires.

3° La propulsion semble être la différenciation progressive due à la rupture de l'équilibre héréditaire par suite des déviations qu'a subi la résultante par l'action de nouvelles énergies qui viennent s'y ajouter, ou bien par suite de nouvelles dispositions des énergies déjà existantes. Cette action imprime ou acquiert un développement nouveau en suivant pas à pas ou en enjambant les séries des valeurs progressives, si minimes que soient les causes des oscillations.

La loi qui régit ces mouvements et que l'on peut appeler "*loi des résultantes*" donne le spectacle des infinies manifestations organiques ou inorganiques qui semblent n'être en définitive que les divers dégrés des intensités radioactives plus ou moins centrifuges, plus ou moins centripètes, avec un champ de développement des vitesses plus ou moins étendu, en proportion avec les vitesses et les directions innées des éléments qui entrent dans les équations.

Cette conception, si téméraire ou si banale qu'elle paraisse donne souvent la clef de l'explication de la plupart des phénomènes des différenciations que l'on constate dans la nature que, ces différenciations se manifestassent par des séries récurrentes ou par des séries progressives. Elle explique aussi les associations, les dissociations, les compositions, les décompositions, les conflagrations, les évaporations, les combinaisons, etc., et fait entrevoir le jeu de toutes les radioactivités des corps en présence, radioactivités dont la résultante amène les déclanchements des ressorts centralisateurs, provoque les délachements des affinités acquises, l'accélération ou le ralentissement des vitesses et détermine des directions différenciées.

La rupture des équilibres n'est-elle pas, en effet, constante? Qu'il s'agisse de rétrogradations ou qu'il s'agisse de propulsion, les affinités subissent des oscillations proportionnelles à l'intensité et à la durée des actions ou des réactions des énergies mises à l'œuvre, depuis les radiations centrifuges jusqu'à la formation des cristaux, ces deux formes suppossées près des extrêmes de l'énergie matérielle.

Tout en abandonnant l'interprétation de ces spéculations à la théorie, il est peut-être utile de déduire les trois propositions suivantes: —

1° Si les énergies qui agissent sur une résultante donnée sont sans effet, l'équilibre persiste et se transmet, par la division, aux descendants, avec les mêmes attributs, supposons 100.

2° Si les ênergies neutralisent ou détruisent une partie des énergies existantes, il se formera une nouvelle résultante qui ne pourra transmettre aux descendants que les attributs qu'elle a pu conserver, supposons 90.

3° Si enfin, les énergies ajoutent leur action à celle des énergies existantes, il se formera une nouvelle résultante qui transmettra aux descendants les attributs accumulés, supposons 110.

C'est à ce mécanisme que peuvent être attribuées les innombrables différenciations que l'on constate sur le cotonnier égyptien.

Quoiqu'il en soit, ces différenciations sont constantes et elles sont d'autant plus sensibles que les individus que l'on examine sont plus nobles.

Ayant porté mes comparaisons sur plusieurs centaines de variétés pendant vingt ans, j'ai eu l'occasion de constater que les influences agissant sur la résultante prise comme terme de comparaison créent de nouveaux équilibres dont la position est le plus souvent rétrogradée.

Cela est dû certainement à l'instabilité des équilibres héréditaires du cotonnier égyptien. Il est vrai que dans le règne végétal, comme du reste dans le règne animal, il n'y a pas de variétés mais des individus; mais chez le cotonnier égyptien, les différenciations sont très appréciables.

Si nous prenons une graine d'une variété de coton rigoureusement contrôlée comme descendant de parents à caractères connus, et si nous examinons ses descendants directs, nous nous trouverons en présence d'écarts très appréciables. La multiplicité des différenciations est telle que l'on peut schématiquement les figurer par un arbre à trois branches: Ces branches porteraient des branches secondaires et des feuilles qui représenteraient autant de groupes et autant d'individus. La branche du milieu porterait des individus ou des groupes d'individus se rapprochant au centre de l'inertie héréditaire initiale; la branche gauche, aurait des groupes et des individus se rapprochant par la rétrogradation au centre primitif ou archégone; et la branche droite aurait des groupes et des individus se rapprochant par l'acquisition de nouvelles tendances au centre créé par la propulsion.

Les oscillations que j'ai remarquées décrivent, tel un pendule, des arcs dont les flèches atteignent toutes les dimensions, depuis l'extrême gauche jusqu'à l'extrême droite. Il en est résulté ainsi des graduations infinies, mais d'une grande instabilité, depuis la valeur 90 jusqu'à la valeur 110 et même parfois au deçà et au delà de ces limites.

Les conséquences pratiques en sont importantes.

Si l'on multiplie une graine prise à l'extrême droite de la courbe des oscillations, elle donnera lieu, au bout de quelques générations, à des différenciations telles que l'on aura les écarts les plus développés, depuis l'extrême droite d'où l'on est parti, jusqu'à l'extrême gauche de l'arbre généalogique primitif. Il en arrive de même quand on multiplie des graines appartenant aux branches du milieu ou de gauche.

Cela est dû dans la majorité des cas au travail intracellulaire où la loi des résultantes se traduit par des oscillations à vitesse différente, par des séries récurrentes à termes de valeur infinitésimale.

La détermination de la valeur des termes d'une série récurrente est en l'espèce irréalisable parce que l'appréciation et la mesure des valeurs des énergies qui contribuent aux oscillations nous échappent.

Ces facteurs restant inconnus, dans l'état actuel de nos connaissances, il est téméraire d'essayer de tracer à l'avance la portée d'une résultante et c'est pour cette raison que tous ceux qui ont tenté d'étudier les phénomènes des trois états de l'équilibre sous la désignation générique d'Hérédité, se sont vu finalement forcés d'avouer la vanité de leurs recherches.

Cet ordre d'idées conduit à la réfutation de certaines règles Mendéliennes qui veulent présumer des termes dans les séries récurrentes ou progressives quand ces termes restent totalement ignorés. Et à moins qu'on ne veuille se complaire à des régressions expectantes, on reconnait que l'on doit revenir de la voie des transgressions dans laquelle engage souvent l'intangible transcendance et fréquemment la généralisation de quelques cas de stabilité apparente insuffisamment expliqués ou définis. Peu importe, en effet, la conception de quelques valeurs dont la réductibilité reste quand même variable et évolue dans le domaine des hypothèses.

Pour avoir voulu généraliser les propositions Mendéliennes, on a tenté d'appliquer en Egypte la méthode de sélection sur les cotonniers. Mais les résultats furent franchement négatifs quand il s'est agi de plantes d'une certaine noblesse (agricole et industrielle). C'est justement parce que les équilibres y sont instables et que les effets de la stabilité relative Mendélienne constatée sur d'autres genres de plantes ne peuvent pas se manifester au même dégré chez le cotonnier égyptien.

Cela se conçoit et s'explique si l'on remonte à l'origine des variétés égyptiennes du coton, variétés qui sont des métis à générateurs plus ou moins stables.

Parmi les variétés égyptiennes il y en a qui montrent un plus grand dégré de résistance à la variabilité, telle que le "Jannovitch" où les tendances archégoniques n'ont pas à la soumettre à des grandes déviations parce qu'elle est prise sur la branche gauche de la variété primitive "Maho" d'origine égyptienne ou bien africaine.

Malheureusement cette propriété de stabilité lui est constitutionnelle et individuelle, mais à la longue, cette variété a subi elle-même des transformations radicales.

Dans mes recherches j'ai essayé de transmettre cette stabilité relative du "Jannovitch" dans mes nouvelles variétés obtenues par croisement; chaque fois que j'ai cru réussir dans ce sens, j'ai été en butte à des dégradations archégoniques qui rendaient mes efforts vains et mes résultats négatifs quoique mes essais ont porté sur plusieurs centaines de tentatives. Je n'ai pas un exemple qui puisse me permettre d'avouer un succès, et je suis contraint de signaler que cette stabilité est très probablement le facteur qui m'a fait assister à des rétrogradations archégoniques très marquées, chaque fois que j'ai employé comme un des générateurs la variété en question.

Il s'agit là probablement d'un mouvement qui imprime des ralentissements dans le travail intracellulaire et qui provoque des déviations de la résultante vers une direction archégonique.

Les caractères héréditaires qui devaient théoriquement exister chez ces métis subissent les rétrocessions d'éléments rétrogradants qui s'y accumulent aux dépens des éléments avancés.

Par contre j'ai réalisé des propulsions très marquées avec des générateurs moins stables et qui par l'évolution m'ont donné des fixités relativement satisfaisantes.

Il y a là la contribution de plus d'un facteur inconnu que revèle la variante des termes des équations. Il n'est pas rare avec des générateurs géants d'obtenir des types nains et réciproquement, sans pouvoir attribuer ces rétrécissements ou ces élargissements du champ de développement à d'autres causes qu'à celles qui doivent intéresser le travail intracellulaire, lors des échanges radioactifs dans la formation de la résultante. Les perturbations qui se signalent dans les résultantes des équilibres des cotons égyptiens sont fréquentes et inévitables même chez les types qui semblent montrer la plus grande résistance. Et si l'on ajoute à l'instabilité constitutionnelle des cotonniers égyptiens l'action de toute sorte de radiations extérieures telles que la lumière et la chaleur prolongées, l'humidité qui intercepte les vitesses des ions, les radiations qui émanent soit de la dissociation des divers sels du sol égyptien, soit des décharges électro-magnétiques, soit d'autres sources, si l'on ajoute l'action de ces agents au jeu intercellulaire des plantes, on ne manque pas de soupçonner les causes primordiales qui peuvent être dûes à la contingence de ces éléments, dans les modifications des champs de développement des résultantes. Mais ainsi qu'il a été dit plus haut, ces contingents dont dispose la nature, sont un appareil de second ordre et n'agissent que lentement. En l'espèce, puisque ces facteurs sont communs à tous les individus sous étude et puisque les variations dans les attributs héréditaires sont diverses, il est prudent de reconnaître que c'est à la loi des résultantes des mouvements intermoléculaires que nous devons attribuer l'exubérance des différenciations auxquelles nous assistons tous les jours.

En fait, en Egypte, nous n'avons pas de variétés de coton fixes, de sorte que celles qui ont un certain âge, telles que le Achmouni, le Mitafifi, le Abassi, le Nubari, le Sakellaridis, etc., ne sont plus que des expressions conventionnelles, leur dégénérescence, après des rétrogradations successives ayant atteint des éloignements très prononcés du point de départ.

Aussi sommes-nous, en Egypte, en présence d'un grave problème qu'est celui de la dégénérescence de nos variétés dégénérescence aggravée par l'abâtardissement et le système non approprié des irrigations.

# FLOWER-BUD AND BOLL SHEDDING OF COTTON IN THE ILORIN PROVINCE, NIGERIA.

By Thomas Thornton, A.R.C.S.

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One of the most serious troubles there is to contend with in this part of Nigeria in the growing of cotton is the shedding of flower-buds and young bolls. It will be well understood that this trouble, if it occurs to any extent, will be of great importance in reducing the crop returns.

On arriving in the Province at the beginning of April of last year, the old cotton which was standing indicated that shedding had been very serious during the previous season. Practically no bolls from which cotton had been picked were to be seen on the lower parts of the plants; almost all the crop had been reaped from bolls which had been developed at the tops of the plants and the ends of the branches.

I arranged to try and determine the cause of this shedding, and with this object in view made a daily record of the flowers opening, the buds and bolls shed, and the various climatic factors.

The minimum temperatures were taken every morning, and the maximum every afternoon. The readings indicated by the wet and dry bulb thermometers were taken daily at 6 a.m., 9 a.m., 12 noon, 3 p.m., and 6 p.m., and the relative humidity of the atmosphere at these times was worked out from these records.

Four different types of cotton were kept under observation: Ishan, an African type; Allen's Improved, an American long staple cotton which had been obtained from Uganda; Nyasaland Upland, another American long staple cotton obtained from Nyasaland; and Durango, a long staple cotton obtained from California.

The flowers opening each day were counted, and each morning all the sheddings were picked up and counted from two rows of each type. The number of plants were: Ishan, 769; Allen's Improved, 849; Nyasaland, 737; and Durango, 772.

The buds and bolls which had been bored by the boll worm were separated from the others and counted.

All these types, with the exception of Nyasaland, were planted on July 15; Nyasaland, which arrived late, was planted on July 28.

The rainfall in August this particular year was very heavy in comparison with other years, between 10 and 11 in. being recorded; September was lower than the average with 8½ in.; the rain ceased on October 19 after nearly 5 in. had been recorded for the month. No more rain fell until February 26 of this year.

The plants grew exceedingly well, not too large, but just a good average size.

In the case of the exotic types, flowering commenced eight weeks after planting, and in four weeks from that time the maximum number of flowers were opening per day. This maximum was maintained for about a week, then flowering began to fall off, and in from eight to nine weeks from the commencement of flowering it had fallen to a minimum. In four months from the time of planting the first flowering period was completed. After this new growth rapidly took place, and in two more weeks a second flowering period had commenced. This last flowering period only lasted from four to five weeks, and the number of flowers opening per day did not rise so high as in the first flowering period.

With Ishan, a native variety, the flowering period was a long drawn out one, the first flowering period only ending when the exotics were finishing their second period. The flowering of Ishan commenced ten and a half weeks after planting; the maximum flowering period was reached five weeks later, and this flowering period was finished seven weeks later. The flowering period of this type, therefore, lasts twelve weeks.

The shedding of flower-buds commenced before any flowers opened, and the shedding of small bolls commenced a few days after the first flowers opened. This shedding of both buds and bolls continued as long as any were being formed.

During the early part of the flowering period the shedding of buds was higher than the shedding of bolls, but towards the end of the period this was reversed, and a larger proportion of bolls were shed.

Almost all the buds shed were only about a quarter of an inch across the widest part of the bracts, and the bolls were mostly shed within a few days of the opening of the flowers. After the bolls were about a week old very few were shed; it was always found that when older bolls were shed the tissues at the bottom of the bolls had turned black, which indicated the presence of disease, or that they had been damaged by the boll worm.

The maximum shedding took place during the wet period, and shortly after the dry season commenced there was a great decrease in the number of sheddings. A decreased shedding continued for about ten days, and then it commenced to increase again, and this increased shedding continued for about three weeks. During this latter heavy shedding period the leaves were also shed.

This latter increased shedding commenced three weeks after the dry season began, and it was evident that the plants were suffering from a decreased water supply. This is what one would naturally expect; the plants had been developed under more moist conditions, and when there was a shortage in the supply of water the plants had to reduce the transpiration area, and the leaves were shed.

After these three weeks of increased shedding new growth again commenced, a new flowering period was begun with the exotics, and the proportion of sheddings rapidly decreased, and this reduced shedding continued until the plants were approaching the end of the flowering period.

The shedding was therefore of two kinds. During the wet period the leaves were not shed with the flower-buds and the bolls, but during the dry season the increased shedding of buds and bolls was accompanied by the shedding of leaves.

During the wet period the shedding was not uniform from day to day, although heavy shedding continued all the time; on certain days the number of sheddings would rise to a very high point, and it was observable that, although the climatic conditions were fairly complex, preceding such days the relative humidity of the atmosphere had been unusually high, accompanied by a cloudy sky and generally rain. The absence of sunshine during August, September, and early October was particularly noticeable.

The high humidity of the atmosphere and the small amount of sunshine appear to be responsible for the shedding during the wet season. For on the arrival of the dry season the atmosphere becomes drier and the amount of sunshine increases and shedding decreases; also, a drier period during the wet season is followed by a decreased shedding, so there appears to be a close connection between the two.

We cannot at the present time explain exactly what effect these conditions have on the cotton plant, but it is possible that the moist conditions affect the transpiration of the plant, and in some way set up an abnormal condition in the plant which results in these organs being shed.

When the dry season commences the atmosphere becomes drier and more sunshine is obtained, and the shedding then decreases; but as the dry season advances still further the plants which had been developed under more moist conditions begin to feel the effects of these changed conditions, and in response to the diminished water supply a shedding of the leaves takes place, together with an increased shedding of flower-buds and bolls. New growth afterwards takes place, a new set of leaves is produced, and a new flowering period is begun. It appears as if the plant has now accommodated itself to the new conditions, and shedding falls to a minimum.

During the wet season the developing bolls were much affected with anthracnose and boll-rot, but as the dry season advanced these troubles almost disappeared.

Boll worms were also a serious trouble, for as many as 25 per cent. of the flower-buds and bolls which were shed during the season had been bored by these worms.

Then, again, the sheddings did not fully indicate the extent of the trouble, as a large number of flower-buds and bolls remained attached to the plants after they had died. These, of course, could not be counted.

What has been said in regard to shedding applies to all the varieties grown, and the general appearance of the plants grown by the natives shows them to have acted in a similar manner to those kept under observation on the experimental farm.

All varieties of soil were represented on the farm; part of the land was sloping, part flat, and part bottom land. Most of it was well drained naturally, and shallow drains were made throughout the farm to carry off the surface water during the constant heavy rains. Deep main drains were also made to collect the water from the surface drains. At one part of the farm there was a drain about 6 ft. deep, but, in spite of different soils and drains, shedding was very similar all over the area.

One often hears it stated that the native varieties are hardier than the imported types, but during the season now under consideration the native types acted in exactly the same way as the others in this matter of shedding. The native types, however, were not so badly affected by the drought. This is accounted for by the fact that they have a much deeper root system, and can therefore draw on the lower layers of earth for moisture.

Practically, no cotton was obtained from any flowers which opened during the wet period, almost all the crop being produced by those flowers which opened after the dry season commenced.

Should occasional showers fall during the dry season it is probable that fair crops may be obtained; but these showers cannot be depended upon, as has been shown this last season, when no rain fell from October 19 until February 26.

This season the crops have been very poor, the amount obtained from the different varieties being only from 50 to 100 lb. of seed-cotton per acre.

On account of the fact that the flower-buds and bolls are shed during the wet season, it might be suggested that seed should be put in at such a time that flowering would only commence after the wet period is finished. With a soil capable of retaining moisture to a high degree this might be possible; unfortunately, the soil in this district is of a very sandy nature, with little power to retain moisture. The result of late planting would be that the plants would only have produced a small growth before the dry season commenced, the root system would be near the surface, and the plants would very quickly suffer from the effects of drought.

In Ilorin Province September is the wettest month of the year, the rainfall during the last nine years varying from 8½ to 17 in. The rainfall afterwards diminishes very quickly, so that before the dry season commences there is practically no period with a moderate rainfall, and then there is not much chance of rain during the dry season.

It is quite possible that in districts where the rainfall eases off more gradually, or where rains are more to be depended upon during the dry season, the results would be more promising.

In the Ilorin Province the indications are that not much of a crop can be expected from flowers which open during the wet season, and that the principal crop will have to be obtained from flowers which open during the dry season.

There is, however, the possibility that special plants may be developed which are able to produce crops from flowers which have opened during the wet period. During the past season I was fortunate in finding a native plant in a native's garden which had ripened all its crop from such flowers. It may be possible to evolve a new type of cotton from this plant, but that, of course, can only be ascertained by experiment. All the seed from this plant was collected, and this season it will be sown to see if the plants raised retain their flowers during the wet period. If such a type of plant can be evolved, the prospects of cotton growing in this Province will be greatly improved.

## PROBLEMS CONNECTED WITH THE NEW EGYPTIAN COTTON PEST, GELECHIA GOSSYPIELLA SAUNDERS, THE PINK BOLL WORM.

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CONSIDERABLE evidence can be brought forward to support the theory that the pink boll worm has been introduced into Egypt within the last ten years, and that it came from India. There are no records available for *Gelechia gossypiella* Saunders from Egypt prior to the autumn of 1910. A few specimens were taken by Mr. F. Willcocks, Entomologist to the Khedivial Agricultural Society, in October of that year. Mr. Andrés claims also to have taken specimens at Alexandria in 1910. In October, 1911, a few were bred out from cotton bolls collected at Fua by myself. These were identified by Mr. Dudgeon, and were then considered by us to be the first specimens recorded from Egypt, neither Mr. Willcocks's nor Mr. Andrés's records having been published at that time. Specimens were also taken by Mr. Willcocks in 1911. The insect was, however, still decidedly rare. At the end of March, 1912, some pupæ of Gelechia were brought to me by Mr. Pappis from Damanhur, having been found by him in cotton seed. A few specimens were bred out of pomegranates in July, 1912.

The pink boll worm was not, however, found doing any damage until the autumn of 1912, when it appeared in enormous quantities at Abu Qeer Estate, near Alexandria, and in considerable numbers everywhere in the Delta.

The first parasites of Gelechia found in Egypt were reared in the autumn of 1912. I bred out one *Chelonella sulcata* Nees, and Mr. Willcocks recorded *Pimpla roborator* Fabr. from his breeding cages. I also found a Pimpla larva in direct connection with a pink boll worm.

Mr. Willcocks also recorded *Pediculoides ventricosus* Newport from Gelechia larvæ. This mite appears to have been a pest in his laboratory, and to have attacked several of the workers.

In the autumn of 1913 Gelechia had already become so abundant as to be recognized as the principal cotton pest throughout the Delta, and had extended its known range considerably in Upper Egypt. We have bred specimens from Heluan, Fayum, Beni Suef, Minia and Assiut in Upper Egypt this year, besides having received specimens from all parts of the Delta.

This brief recapitulation of the known history of the insect in Egypt points to its recent introduction. It is hardly possible to understand how an insect which was a great rarity in 1910 should have become the major pest by 1913 on any other assumption. The first introduction of the insect must have taken place only a few years prior to 1910.

Until recently the origin of the insect in Egypt was rather a mystery. Since 1904 all importation of cotton seed into Egypt has been totally prohibited, the only exception until 1912 having been in favour of unginned cotton from the Sudan. *Gelechia gossypiella* does not, however, appear to occur in the Sudan as yet, or has not hitherto been recorded from there. It can consequently hardly have been imported from the Sudan. Some light has, however, recently been thrown upon the mystery. A consignment of "ginned" cotton from India was held up in the autumn of 1913 at Alexandria, as it was found to contain seeds in great quantity. It was allowed to be delivered to the consignee on condition that all the seed should be removed from the lint in the presence of an Inspector of the Ministry of Agriculture. Although the cotton had been steam-pressed several living *G. gossypiella* larvæ were discovered in the Indian cotton seed. The amount of seed in the bales varied very considerably, in one sample taken there were seeds at the rate of 750,000 to the ton of lint.

Having discovered this possible source for the introduction of *G. gossypiella* into Egypt, the question arose as to the date of the first importation of Indian cotton into the country, especially as the importer stated that he had not dealt with Indian cotton before 1910. The following table, kindly supplied by the Director-General of Customs, shows that considerable quantities have been imported from India since 1903, in all about 466 tons, of which 350 tons were landed at Port Said, about 62 tons at Suez, and nearly 54 tons at Alexandria. The destination of the cotton imported cannot now be followed up, but it is unlikely that any of it was manufactured at Suez or Port Said. Some may have been re-shipped to Alexandria from Port Said, as has happened this winter. In any case, the coincidence that the first estate to be badly damaged in Egypt was within a few miles of Alexandria (Abu Qeer) is remarkable.

QUANTITY AND VALUE OF COTTON IMPORTED INTO EGYPT FROM INDIA, 1900-1913.

| Years | Alexandria | | Port Said | | Suez | | Total | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value |
| | Kilos. | £ E. | Kilos. | £ E. | Kilos. | £ E. | Kilos. | £ E. |
| 1900 | — | — | — | — | — | — | — | — |
| 1901 | — | — | — | — | — | — | — | — |
| 1902 | — | — | — | — | — | — | — | — |
| 1903 | — | — | — | — | 20,510 | 294 | 20,510 | 294 |
| 1904 | 14,360 | 201 | — | — | 11,467 | 183 | 25,827 | 384 |
| 1905 | — | — | — | — | 9,150 | 107 | 9,150 | 107 |
| 1906 | — | — | 80,552 | 3,235 | 688 | 46 | 81,240 | 3,281 |
| 1907 | 9,366 | 187 | 137,436 | 5,672 | 15,198 | 617 | 162,000 | 6,476 |
| 1908 | 21,460 | 296 | — | — | — | — | 21,460 | 296 |
| 1909 | — | — | 31,206 | 312 | — | — | 31,206 | 312 |
| 1910 | 8,254 | 341 | — | — | 4,829 | 172 | 13,353 | 513 |
| 1911 | — | — | — | — | — | — | — | — |
| 1912 | — | — | 10,998 | 494 | — | — | 10,998 | 494 |
| 1913 | 17 | 2 | 8,995 | 4,549 | — | — | 90,012 | 4,551 |

N.B.—The embarkation of this cotton is chiefly effected at Bombay.

It is not intended in thus sketching the probable method of introduction of the pink boll worm to impute blame to anybody. The importers were not doing any illegal action, and were not aware that the importation of badly ginned Indian cotton was attended by any special risk.

Hitherto the pink boll worm is the only insect known to have been introduced in this manner; it is, however, quite possible that other cotton pests may have been brought in at the same time and in the same way.

*The importation of Egyptian cotton seed into cotton-growing countries where* Gelechia gossypiella *does not yet exist ought to be strictly prohibited,* or else history may be expected to repeat itself.

The life-history of the pink boll worm in Egypt is already fairly well known, and in most respects resembles the Indian. Apparently it is in a transition state between a univoltine and a multivoltine insect.

Some larvæ resulting from the October or November broods of moths pass the winter dormant as full-fed larvæ, pupating in spring, or even in summer. Out of these pupæ some moths emerge early in June and July, others still later in the year, and it appears to be possible (on the authority of Mr. Willcocks) that some specimens emerge so late as to produce larvæ that will again hibernate. Such insects are consequently strictly single brooded. On the other hand, a large number of the spring pupæ give rise to moths in June, the progeny of these moths appear in their turn to fly in July and August, and then generation seems to follow generation until the second half of December. Of the larvæ of the last generation some pupate and emerge as adults late in December and the first week in January; these are probably lost for the purpose of propagation: others hibernate as larvæ, as already stated, and carry on the life of the species.

The exact length of time required for a generation can consequently be seen to vary from one year to a few weeks. Cold evidently has a retarding influence on the larvæ. A large number of larvæ extracted from seeds at the end of January were placed in glass tubes. Of these some were kept in an incubator at 37° C., others at 27° C., still others at room temperatures varying from 10° to 15° C. All the larvæ in the two lots at warm temperatures had spun cocoons for themselves at the end of two days; those kept at room temperatures remained torpid, neither moving nor spinning for nine days, after which they began to spin cocoons. Some of the larvæ kept at 37° C. started pupating after eight days, others remained dormant, but healthy, for three further months without pupating, and were still in the larval state at the time of writing (April 11). The larvæ kept at 27° C. had started pupating after nine days, some lingering in the same way as before mentioned as larvæ up till the middle of April.

As all these larvæ were kept under exactly the same conditions, heat does not appear to be the factor controlling the length of their hibernation or æstivation period. Moisture combined with heat appears to be fatal to them. Of thirty-eight dormant larvæ exposed to 37° C. in a moist chamber, only two had spun cocoons after ten days, the other thirty-six being dead. The two which spun cocoons died before pupating. Of the larvæ kept dry at 37° C., 30 per cent. were dead after ten days, none of those kept at 27° C. died, and only 5 per cent. of those kept at room temperatures.

No experiments have yet been undertaken to discover whether all the larvæ of the summer generations pupate and hatch as adults in short periods, or whether some of them æstivate and pupate later to hatch next year, in the manner followed by the larvæ of the previous autumn.

*Gelechia gossypiella* larvæ have in Egypt been found feeding on cotton, okroe, or bamiah (*Hibiscus esculentus*), tehl (*Hibiscus cannabinus*), and at Mariout on *Malva* sp., and on pomegranates. Usually the seeds are attacked, but the larvæ are also capable of feeding in flower buds.

It is not possible to detect the presence of Gelechia larvæ in attacked bolls without opening the bolls; Earias larvæ leave a large hole at the side of the boll or shoot they feed in, and are easily detected by the accumulation of frass below the hole. Exactly how the young Gelechia larvæ enter the bolls has not been observed; it may possibly happen through the stigma of the flower, or else the minute hole made by the larvæ when entering the boll closes up again. For this reason there is no possibility of combating the insect by pulling off attacked bolls, a method which might be expected to be of help in checking the early generation of Earias. Gelechia larvæ also do not damage the cotton in the same way as Earias larvæ do. Whilst ordinary boll worm larvæ feed on the developing lint, and by their presence damage and stain the lint in the section of the boll they have attacked, Gelechia larvæ feed on the seeds only, hollowing them out and living in the cavity they make. This causes twofold damage. The lint developing on an injured seed does not develop normally, the extent of the damage depending on the developmental stage of the seed when first attacked. The lint may consequently hardly develop at all, remain shorter and weaker than normal, or be scarcely affected. The injured seeds naturally lose their germinating power and value for crushing. The lint is not, however, stained by the larvæ nor blackened by sooty mould, as happens frequently after an attack by Earias.

During the course of its development each Gelechia larva may attack more than one seed; at the time of maturity of the bolls it is normal to find "double" seeds; the larvæ, after having more or less completely hollowed out a seed, attaches a second seed to the opening of the first by a web of silk threads, and feeds on the contents of the second seed. A third seed is sometimes attacked and stuck to the first two in the same way. Such double seeds are readily found in unginned cotton by passing the lint between the fingers and feeling for the seeds. That they are very firmly spun together can be seen by the fact that the double seeds mostly pass intact through the gins, with the enclosed larvæ unhurt.

We have invariably found Gelechia pupating inside the double seeds, except where this has been experimentally prevented, though, according to Mr. Andrés, the larvæ leave the seeds to pupate elsewhere. When removed from the interior of the seed, full-grown larvæ spin new cocoons for themselves, the period required for them to start spinning evidently depending, as already stated, to a great extent on temperature.

Some larvæ which had been removed from their original double seeds in making their cocoons employed nothing but their own silk, economizing the silk by leaving the glass of the tubes in which they were confined to form part of the walls of the cocoon. Others, however, utilized foreign bodies to strengthen or to help out the web, or perhaps with an instinct to make the cocoon less visible. Some blotting paper in the moist chamber was utilized by two larvæ, being reduced first to fluff and then incorporated in the web. Another larva, kept in a corked (dry) tube, made cork dust serve, biting up the cork to produce the dust. Another, which had access to cotton-wool, utilized cotton fibre. One larva, which by accident had entered a narrow glass tube, simply spun a transverse web on either side of itself, closing up the tube in both directions with a tight, flat, circular membrane.

In winter hibernating larvæ may be looked for wherever cotton seed is to be found. Probably the majority will be found in seed that has been ginned and stored. Some seed we were using for experimental purposes was infested to the extent of one worm to every ten seeds, and at least 30 to 40 per cent. of the seeds were damaged, but this was an exceptionally bad sample. After the last picking a large number of immature bolls remain on the cotton sticks; these bolls are invariably infested. The cotton sticks are uprooted and stored in the villages for fuel, and the capsules adhering to them form an important reservoir for the insect to pass the winter in. As diseased bolls readily fall to the ground, large numbers of worms can be found hibernating in bolls lying on the ground. Bolls collected on the ground in January were found to contain a number of living worms, and still more dead ones.

It is impossible to make a reliable estimate of the amount of damage done by the pink boll worm, or even to give figures to show the proportion of damage done by Gelechia and Earias respectively.

What figures are available to show the relative amount of damage done in 1911, 1912, and 1913 by Gelechia all trend in the same way. In localities where any damage was done in 1911, great damage followed in 1912, and much less damage was observed in 1913. Of course, for very many localities no figures exist for 1911 or 1912, although extensive damage has been reported from them in 1913. It is hoped, and seems probable, that in these cases also the maximum of damage has already been reached, and that the 1914 crop will be less affected. The damage will probably always be most severe in new localities.

The relative proportions of Gelechia and Earias present in cotton bolls have also been worked out for several localities, and it is found, as was to be expected, that Gelechia is commoner than Earias in some localities, whilst the opposite result is obtained in other places. The figures available do not show anything worth recording yet, but will be useful for comparison in coming years.

If it has been impossible to get a reasonably accurate estimate of the total damage by examining the destruction done in counts of large numbers of bolls, or of the damaged seeds in bolls of entire plants collected for the purpose, it is almost as impossible to obtain results by comparing the returns for the total crop in 1911, 1912, and 1913.

In 1911 the crop was 7,386,328 kantars, in 1912 7,499,100 kantars, and in 1913 the estimate of the Department of Agriculture, which appears to be very close to the exact quantity, is 7,554,000 kantars, yet there is no doubt that a very severe and general attack occurred in 1913. These figures refer to the lint; the damage is, however, more evident in the seed than in the lint. This year it has been almost impossible to find cotton seed free from Gelechia larvæ; some bad samples examined by us had at least 30 to 40 per cent. of damaged seeds.

The statement has just been made that the damage in any locality seems to reach its maximum in the first or second year of the known existence of Gelechia in that locality, and that thereafter the number of pink boll worms observed there in a given number of bolls decreases. Such a decrease can be brought into connection with observations of their parasites.

The following parasites have been bred from or observed on *Gelechia gossypiella: Pimpla roborator* Fabr., *Chelonella sulcata* Nees, *Limnerium interruptum* Holmgr., *Pediculoides ventricosus* Newport, and *Microsporidium polyedricum* Bolle.

*Pimpla roborator* is an Ichneumonid with a very wide distribution throughout the palæarctic region, and is known to infest boring larvæ of insects belonging to widely different Orders. It was common in Egypt prior to the advent of the pink boll worm, and has but recently taken to parasitizing Gelechia larvæ. *P. roborator* was the first parasite observed on the pink boll worm, and still remains the commonest parasite of that pest in Egypt. The part it plays in combating Gelechia is without doubt a very important one. It has become quite a familiar object in magazines where unginned cotton is stored within the range of the pink boll worm.

*Chelonella sulcata*, also an Ichneumonid, appears to have been rare before last autumn (1913). Only one specimen was known to us in 1912, which we had bred from Gelechia; nevertheless, our breeding cages during the last crop season produced large numbers of this parasite. We have not hitherto bred Chelonella from any other insect larva, and are not in a position to say whether this parasite was introduced along with its host, or whether it is indigenous to Egypt; this season it has been the second most important parasite of the pink boll worm.

*Limnerium interruptum* is also an Ichneumonid insect, and is evidently able to parasitize insects other than *Gelechia gossypiella*, as the species is known to occur in England. In Egypt it has hitherto only been bred from Gelechia, being otherwise so rare that no captured specimens have yet been recorded. The pink boll worm has, however, provided a convenient and common prey, and it has multiplied enormously in some places. Its range is not yet co-extensive with the range of Gelechia, and it must still be considered a very local insect.

*Pediculoides ventricosus* was discovered infesting Gelechia larvæ by Mr. Willcocks in 1912, and in 1913 became so common that the work of unloading Egyptian cotton seed in English ports was interfered with, as the mites also attack man when their normal hosts are wanting. This parasite also seems to be somewhat local in its distribution; Mr. Willcocks's laboratory is stated to have been badly infested. It has not been noticed in our buildings, although very large quantities of cotton seed and Gelechia larvæ have been handled by us. To obtain specimens we had to examine samples of seed from a great number of localities. Whether the mite will ever be of much help in checking *Gelechia gossypiella* still remains to be seen. It appears to breed fastest in warm and somewhat moist surroundings—conditions that hardly obtain in seed stores in Egypt during the winter.

*Microsporidium polyedricum*, the protozoan parasite which caused so much destruction to the cotton worm (*Prodenia litura* Fabr.) in the last two years, has also been observed in Gelechia.

As time goes on other parasites will doubtless be discovered attacking Gelechia. *Rhogas Kitcheneri* is most probably also a parasite of the pink boll worm, as we have bred it from other lepidopterous larvæ, in addition to Earias, which was its first discovered host.

The amount of mortality due to all these parasites has been found to vary in the seed samples examined from 10 to 40 per cent.; it may even reach a higher percentage if outside reports be true.

Parasites and diseases are evidently helping to combat the worm, and when the measures devised by the Ministry of Agriculture have been enforced we will probably have the pest well in hand. The existing legislation against the boll worm (Earias) is being extended to make it applicable to Gelechia also. For this purpose clauses are being added to the law making it an offence to store cotton sticks for fuel after a certain date each year without having destroyed all attached bolls, and permitting the Government, if necessary, to have bolls removed at the expense of the owner. Cotton sticks, it must be remarked, form the principal fuel supply for large parts of Egypt.

It would not, however, be sufficient merely to destroy all the larvæ and pupæ hibernating in the bolls, in the field, or in the stacked firewood, unless something were done to destroy the larvæ and pupæ sheltering in the cotton seed intended for planting.

The Entomological Section of the Ministry of Agriculture has made a careful study of the methods for use in destroying the pink boll worm in cotton seed without at the same time injuring the seed.

It has been impossible to find a satisfactory system of dealing with the pink boll worm after the cotton seed has been sacked. If any treatment is to be applied successfully the seed must be loose, whether in large or in small quantities.

The best results have been obtained from the following methods:—

(1) *Hot-air Treatment.*—It was anticipated and proved to be correct that there is a difference in the temperatures necessary to kill Gelechia larvæ and cotton seed. A practical temperature under 0° C. was not found; on the other hand, the worms cannot exist at 50° C. for longer than is required to heat them through and through to that temperature. Cotton seed, on the other hand, will under normal conditions remain unaffected if thoroughly warmed up to 65° C., and possibly up to 75° C. However, both worms and seed can stand much higher temperatures for short periods, the rule being, the higher the temperature the shorter the period, and total mortality occurs amongst the worms long before the seed suffers.

In treating seed with hot air it was found necessary, if uniform results were to be obtained, to spread out the seeds in a single layer, in order to give the heated air access to every single seed. Other factors to be considered were the heat conductivity of the material on which the seeds were carried, the initial temperature of the seed, the temperature employed, and the time of the exposure. The seed must not previously have been wetted, or wetted and dried. In order to kill the worms and not to hurt the seed, it was necessary to adjust all these factors, which could be adjusted in the machine used, in such a way that the worms and seed should reach a minimum temperature throughout of about 55° to 60° C. The material of the carrier would normally be a constant, the depth of the seed layer also. The initial temperature of the seed in our experiments was not considered, as it would not have varied more than one or two degrees from 15° C., that being the temperature of our laboratory. In the practical application of the hot-air treatment the initial temperature of the seed might become important, as it could conceivably vary by

30° to 40° C. in Egypt according to the season of the year. However, the main variable factors will remain the temperature of the hot air used, and the time allowed for action.

A machine to apply the hot-air method of destruction of Gelechia larvæ would in principle consist of an endless band to carry the seed, heated either by steam pipes or other radiators, or else heated by a hot-air blast. Instead of one, several endless bands might be required, one above the other, each receiving the seed from the one above it, and discharging on to the one below in order to economize space.

As already stated, the temperature required would depend on various factors, amongst which the construction of the machine and the time allowed for the seed to traverse the heated part are the most important. The permissible temperature would have to be found for each machine.

A machine on the lines sketched above has been erected by the State Domains Administration by way of a large scale experiment, and having been found to be satisfactory, a full-sized machine is now being built by that Administration.

(2) *Treatment with Gases.*—Cotton seed can also be treated successfully by carbon bisulphide and other gases. Again an indispensable condition is that the seed must not be treated in sacks. We find that the best results are obtained by placing the seed in vats that can be sealed hermetically, and by making the gas circulate through the seed by means of a pump, which sucks the gas out through a pipe at the top of the vat and forces it in again through a pipe entering from below. Without some such arrangement the gases do not seem to penetrate to any depth through the seed, and consequently are not able to kill the larvæ.

We are erecting a machine with which we will be able to deal with 40 to 50 tons of seed daily as an experiment. This machine has already been used on a few tons of seed intended for exportation, and the samples examined showed that the operation had been successful.

The gas giving the best results has hitherto been carbon bisulphide, which kills all larvæ present in half an hour, if applied at the rate of 1 c.c. of the fluid to each litre space contained in the cotton seed vat. Exposures of less than half an hour are not always safe, nor are quantities of less than 0·1 per cent. carbon bisulphide.

Hydrocyanic acid gas also gives good results, but requires longer to kill the worms. Sulphur dioxide is also distinctly promising, but it has not been possible for us to make a thoroughly satisfactory experimental arrangement for the use of this gas on a small scale.

(3) *Treatment with Cyllin.*—A remedy usable only on a small scale is immersion in cyllin and water. We have found that steeping for twenty-four hours in solutions of 1 : 100, 1 : 500 and 1 : 1,000 has no injurious effect whatever on the seeds, and yet kills every worm in the sample. The only objection to the method is that the seed must be instantly planted, as the long immersion is apt to start the germination. The seed will germinate, and the seedling grows readily when watered with 1 per cent. cyllin.

In an Appendix given at the end of this paper will be found the figures on which all these deductions are based.

In our opinion the pink boll worm, which has in three years sprung into existence as a major cotton pest, need not be feared as much as either the Egyptian cotton worm or the ordinary boll worm (Earias), for, provided the desired legislation is enforced and the power is given to carry out the necessary operations, it ought to be possible to restrict its ravages to a minimum.

# APPENDIX.

## Table showing Effects of Insecticides on Gelechia Larvæ and Cotton Seed.

| Insecticide used | Time allowed for action | Gelechia larvæ | | | Cotton seed | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | Living | Dead | Percentage dead | Germinates | Fails | Percentage germinated | |
| | Minutes | | | | | | | |
| Carbon bisulphide, pumped as gas through cotton seed container | 30 | 0 | 25 | 100 | 70 | 45 | 61 | 1 c.c. to litre space. |
| | 30 | 0 | 20 | 100 | 80 | 205 | 28 | |
| | 30 | 0 | 31 | 100 | 49 | 67 | 42 | |
| | 30 | 1 | 35 | 97 | 49 | 42 | 54 | 1·5 c.c. to litre space. |
| | 30 | 0 | 34 | 100 | 36 | 61 | 37 | 6 c.c. to litre space. |
| Hydrocyanic acid gas, pumped through cotton seed container | | | | | | | | The gas was developed from— |
| | 30 | 1 | 11 | 92·5 | 81 | 8 | 91 | 1 grm. sodium cyanide. |
| | 30 | 4 | 26 | 87 | | | (good seed) | 1 c.c. sulphuric acid. |
| | 60 | 0 | 28 | 100 | | | | 2 c.c. water. |
| | 30 | 13 | 20 | 60 | 34 | 81 | 29 | 2 grm. sodium cyanide. |
| | 60 | 0 | 28 | 100 | 57 | 50 | 53 | 2 c.c. sulphuric acid. |
| | 60 | 0 | 29 | 100 | | | | 4 c.c. water. |
| | 30 | 0 | 15 | 100 | 35 | 55 | 48 | 5 grm. sodium cyanide. 5 c.c. sulphuric acid. 10 c.c. water. |
| | 30 | 0 | 12 | 100 | 34 | 35 | 48 | 10 grm. sodium cyanide. |
| | 60 | 0 | 10 | 100 | 28 | 41 | 40 | 10 c.c. sulphuric acid. 20 c.c. water. |
| Sulphur dioxide gas, pumped through cotton seed container | | | | | | | | The gas was developed from— |
| | 30 | 6 | 12 | 66 | 87 | 49 | 63 | 5 grm. sodium sulphite. |
| | 60 | 2 | 19 | 90 | 74 | 63 | 54 | 5 c.c. sulphuric acid. 10 c.c. water. |
| | 30 | 2 | 25 | 92 | 83 | 72 | 53 | 10 grm. sodium sulphite. |
| | 60 | 0 | 18 | 100 | 89 | 49 | 64 | 10 c.c. sulphuric acid. 20 c.c. water. |
| | Hours | | | | | | | Strength of solution used— |
| Cyllin, seed soaked in solution | 24 | 3 | 13 | 81 | 39 | 55 | 42 | 1 : 4,000. |
| | 24 | 0 | 12 | 100 | 37 | 47 | 44 | 1 : 2,000. |
| | 24 | 0 | 50 | 100 | 123 | 126 | 49 | 1 : 1,000. |
| | 24 | 0 | 16 | 100 | 108 | 151 | 42 | 1 : 1,000. |
| | 24 | 0 | 9 | 100 | 33 | 48 | 40 | 1 : 1,000. |
| | 24 | 0 | 7 | 100 | 36 | 50 | 41 | 1 : 500. |
| Controls | | 32 | 18 | 36 | 54 | 50 | 53 | These controls were made from the same seed as was used in all the experiments, except the first one recorded for hydrocyanic acid gas. |
| | | 5 | 20 | 20 | 56 | 52 | 52 | |
| | | 16 | 15 | 48 | 40 | 38 | 41 | |
| | | 28 | 6 | 18 | 135 | 154 | 46 | |
| | | 24 | 6 | 20 | 113 | 187 | 37 | |
| | | 6 | 3 | 33 | 133 | 129 | 50 | |
| | | 4 | 6 | 40 | 19 | 175 | 10 | |
| | | 36 | 19 | 34·5 | 127 | 155 | 42 | |
| | | 43 | 10 | 19 | 104 | 187 | 36 | |

# THE BOLL WORM IN EGYPT.

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Previous to 1911 the name boll worm was used in Egypt exclusively in application to one species (*Earias insulana*, Boisd.), but in the year named a new pest appeared which resembled the other in its depredations upon cotton bolls, and to which the name "pink boll worm" has been applied to distinguish it.

Owing to the points of difference between the two species being somewhat marked it is necessary to refer to each separately, and the present paper therefore deals only with the common boll worm (*E. insulana*, Boisd.); it is proposed to give an account of the pink boll worm (*Gelechia gossypiella*, Saund.) in a subsequent paper.

In a special article which was contributed by me to the British Section of the International Association for Tropical Agriculture, and which was published in *The Bulletin of the Imperial Institute*, vol. x (1912), under the title of "The Cotton Worm in Egypt," I dealt with the history of the inception of cotton cultivation in Egypt and the gradual increase of production.

There was no record of the appearance of any cotton pest in Egypt until after cotton had been established in the country for forty years; but about that time closer attention seems to have been given to the reasons for the shortage of crops in some seasons which had hitherto been placed to the account of water scarcity only.

As a result of this the Earias cotton boll worm was discovered, an insect which had previously been known to exist in India, from which country it may have been introduced, and from where it is abundantly evident the pink boll worm came recently.

The insect commonly referred to as the boll worm, "ver de la capsule" or "dud el luz," in Egypt is identical with one of the species which is destructive to cotton in India, and is the larva or caterpillar of a night flying moth. It has received its common name from the habit it possesses of boring into and consuming the contents of cotton bolls or seed capsules. Although the injury effected is somewhat similar to that caused by the American boll worm (*Chloridea obsoleta*, Fabr = *Heliothis armigera*, auctorum), the Egyptian and Indian insect referred to here enters the boll completely, and lives within it for a considerable time, whereas the American insect lives for the most part outside. The remedial treatments, therefore, to be applied to the two species are dissimilar.

In appearance the two insects are quite different through all their stages. It may be mentioned that the American boll worm occurs also in Egypt, but is rare, and has never established itself as a serious menace to crops.

The zoological position of the Egyptian boll worm is in the family Noctuidæ, sub-family Acontianæ; and the genus *Earias* to which it belongs is included as an aberrant one, for which reason it has been referred by various authors to the families Tortricidæ and Arctiadæ in accordance with the presence of certain characters peculiar to those families.

From the form of the cocoon it would appear to be allied to some insects included in the Noctuid sub-family of Sarrothripinæ and the Arctiad sub-family Nolianæ. Considerable confusion has been caused by the separation, by Boisduval himself, of the Egyptian insect under the name of *Eriophaga gossypiana* from his species *Tortrix insulana* and *Earias siliquana* from Madagascar, but later authorities are agreed regarding the identity of all as one species under the oldest specific name of *insulana* in Hubner's genus *Earias*, which was described in 1818, and of which *E. fabia*, Stoll., is the type.

The following synonymy is taken from that appearing in Sir George Hampson's catalogue of the *Lepidoptera phalænæ*, with a few additional references from local publications:—

*Earias insulana.*

*Tortrix insulana*, Boisd., *Faun. Madag.*, p. 121, pl. 16, f. 9 (1833).

*Earias smaragdinana*, Zell., *K. Vet.-Akad. Handl* p. 79 (1852).

*Earias siliquana*, Herr-Schäff, *Schmett.* Eur. ii, p. 448, Nyct ff. 1-3 (1853).

*Earias frondosana*, Wlk., *Cat. Lep. Het. B.M.*, xxvii, 204 (1863).

*Earias frondosana*, Butler, *Ill. Het. B.M.* vi, p. 14, pl. 105, f. 1 (1886).

*Acontia xanthophila*, Wlk., *Journ. Linn. Soc. Zool.*, vii, p. 50 (1863).

*Earias simillima*, Wlk., *Cat. Lep. Het. B.M.*, xxxv, p. 1775 (1866).

*Earias simillima*, Kirby, *Cat. Lep. Het.*, p. 282 (1892).

*Earias chlorion*, Rmbr., *Cat. Lep. S. And.* ii, pl. 15, fig. 6 (1866).

*Earias gossypii*, Frauenf., *Verh. zool.-bot. Ges Wien*, xvii, p. 791 (1867).

*Earias anthophilana*, Snell., *Tijd. v. Ent.*, xxii, p. 96, pl. 8, fig. 1 (1879).

*Earias anthophilana*, Kirby, *Cat. Lep. Het.*, p. 282 (1892).

*Earias tristrigosa*, Butl., *Proc. Zool. Soc. Lond.*, p. 614 (1881).

*Earias tristrigosa*, Kirby, *Cat. Lep. Het.*, p 282 (1892).

*Eriophaga gossypiana*, Boisd., *Memoir sur l'insecte ravageur des plantes de coton en Egypte, Rapport de la Commission du Gouvern.* (1872).

*Eriophaga gossypiana*, Ismalum, *Bull. Com. Agric. Cairo*, i, p. 27, Ann. B (1884).

*Earias insulana*, Cotes and Swinhoe, *Cat. Moths Ind.* (1887).

*Earias insulana*, Kirby, *Cat. Lep. Het.*, p. 281 (1892).

*Earias insulana*, Hampson, *Moths Ind.*, ii, p. 133 (1894).

*Earias insulana*, Staud., *Cat. Lep. Pal.*, p. 362 (1901).

*Earias insulana*, Willcocks, *Year-book, Khediv. Agric. Soc.*, Cairo, p. 57 (1905).

*Earias insulana*, Hampson, *Cat. Lep. Phalænæ*, vol. xi, p. 502 (1912).

*Earias dorsivitta*, Staud., *Iris*, x, p. 165 (1897).

*Earias ochreimargo*, Warren, *Seitz I*, iii, p. 296 (1913).

*Earias semifascia*, Warren, *Seitz I*, iii, p. 296 (1913).

A contribution by Mr. F. C. Willcocks to the *Year-book of the Khedivial Agricultural Society, for* 1905, pp. 57-91, comprises a complete account of the life-history of the insect, and description of all the stages. The following account of the three incomplete stages is quoted from the above *in extenso*.

### The Egg.

The egg is approximately 0·5 mm. in diameter; the height is almost equal to the diameter. When first laid it varies in colour from a pale turquoise blue to bluish-green; later the green tint generally becomes dominant, a brownish ring tinged with green appears around the upper third of the egg, and an area of the same colour in the centre.

The egg is more or less globular in form, and is surmounted by a prominent crown; viewed from above the outline is circular. The shape is variable according to the conditions under which the egg has been laid. If deposited on a hairy surface, such as a bamiah fruit (*Hibiscus esculentus*), the base is usually much rounded, and consequently the spherical shape is well marked; but when the egg is laid on a smooth, unyielding surface, or if pressure is brought into use in order to fix it in some crack or irregularity on the surface of the object on which oviposition is taking place, the basal part is more flattened, and the globular form is thus lost.

In general appearance the egg is not unlike a miniature poppy head, except, of course, for the more complicated structure and sculpturing on the shell.

The surface is marked with numerous vertical and very slightly zigzag ribs, which stand out very prominently from the sides. These ribs can be classified into two sets of long and medium length respectively.

The long ribs project at the top and curve away from the surface, and thus form the points of the large crown which surmounts the upper portion of the egg. The second series or shorter longitudinal ridges, which alternate with the long ones, stop at the base of the crown, and do not project outwards so as to form points.

Within the large crown, and at a very slightly higher elevation, there is a much smaller one which surrounds the micropyle.

The points of the latter are slender, upright, and generally bifid at the apex; they appear to be formed by ribs, which proceed in a slight upward curve from the points of the large crown; the single ridges, which spring from two of the outer teeth, converge and form a point in the micropylar crown. However, the points comprising the latter are not half the number which form the primary crown, because some of the ribs which spring from the teeth of the larger crown run in between those which make up the micropylar crown.

The secondary crown surrounds a small area, more or less flat, in the centre of which is the micropyle. This space is sculptured with several delicate converging ridges, which form a somewhat rosette-shaped pattern.

The vertical ribs are joined by a series of small concave transverse striæ, which are alternately opposite each other, the enclosed areas being markedly concave. The sculpturing becomes obsolete at the base. The whole shell reflects light very strongly, which gives the egg the appearance of being made of blown glass.

*Oviposition on Cotton.*—The eggs are laid on various parts of the cotton plant, but, as far as Mr. Willcocks's observations go at present, the bolls, terminal buds, and perhaps also the squares, appear to be the favourite positions for oviposition. They may also be found on the large flower buds, and occasionally on the petioles and in the axils of the leaves, or on the leaves themselves.

As a rule each female lays a single egg on a boll, but sometimes she lays two, or possibly more. However, as several females oviposit on the same capsule, it is by no means unusual to find quite a number of hatched and unhatched eggs in different stages; this is more common towards the end of the season. The favourite situation on the boll, for the deposition of the egg or eggs, is in one of the grooves near the apex. They are also deposited on the sides of the fruit and on various parts of the involucre.

In the case of squares they are laid on the involucre, frequently on the teeth. When vegetative buds are chosen the eggs are placed on the small leaves.

*Oviposition on other Plants.*—In the case of tehl (*Hibiscus cannabinus*) and bamiah (*H. esculentus*), the eggs are laid on the fruits and flower buds. The writer has sometimes found as many as twenty eggs and egg-shells on a single small fruit of the latter plant. On the garden hibiscus (*H. rosa-sinensis*) the females oviposit on the flower buds and in the axils of the leaves.

*Time of Oviposition.*—Egg-laying takes place during the night. Probably the females commence to oviposit at dusk between intervals of feeding, as they are very active on the wing at this time. The moths have never been noticed flying about during the daytime, except, of course, when they have been disturbed from their day retreats; they will then only fly a short distance and quickly settle again.

*Number of Eggs laid and Length of Egg-laying Period.*—It has not been possible to obtain sufficient data on this subject to make any definite statement as to the total, or average number of eggs, which a female of this species is capable of producing. A female which was kept under observation in the laboratory in September, and supplied with food in the form of cane-sugar syrup, laid on five consecutive nights a total of 233 eggs. On the first night 96 were deposited on the food plants and various parts of the cage; on the second 58, on the third 49, on the fourth 19, and on the fifth and last night only 11 were laid.

In this instance the egg-laying period only lasted five nights, but in the case of some females which were bred and kept under observation in December, 1904, it was very much further extended, although the total number of eggs laid in each case was considerably less than the above female gave rise to. This may be accounted for

# Egg-laying Record of Six Boll Worm Moths.

Eggs laid on consecutive nights — December, 1904

| No. of females | Egg-laying commenced | Female died | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Dec. 7 | Jan. 20 | 38 | 9 | 19 | — | 24 | 11 | 6 | 2 | 6 | 8 | 0 | 0 | 8 | 2 | 5 | 0 | 7 | 1 | — | 15 | 1 | 1 | 0 | 1 | 0 |
| 2 | Dec. 7 | Dec. 15 | 50 | 4 | 50 | — | 11 | 13 | 2 | 10 | * | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 3 | Dec. 8 | Jan. 12 | — | 42 | 6 | — | 22 | 6 | 12 | 2 | 1 | 14 | 1 | 0 | 0 | 16 | 0 | 0 | 3 | 0 | — | 6 | 1 | 0 | 0 | 0 | 0 |
| 4 | Dec. 8 | Jan. 7 | — | 33 | 26 | — | 30 | 4 | 8 | 7 | 0 | 10 | 0 | 0 | 10 | 0 | 1 | 0 | 10 | 12 | — | 3 | 0 | 1 | 4 | 0 | 5 |
| 5 | Dec. 8 | Dec. 26 | — | 46 | 9 | — | 10 | 3 | 9 | 7 | 0 | 0 | 2 | 6 | 3 | 3 | 1 | 0 | 0 | 0 | 0 | * | — | — | — | — | — |
| 6 | Dec. 13 | Jan. 18 | — | — | — | — | — | — | 13 | 31 | 7 | 2 | 13 | 8 | 7 | 6 | 5 | 1 | 0 | 7 | — | 1 | 0 | 0 | 6 | 0 | 0 |

Eggs laid on consecutive nights — January, 1905

| No. of females | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | Total eggs laid |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | — | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | * | 171 |
| 2 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 140 |
| 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * | — | — | — | — | — | — | — | — | — | 134 |
| 4 | 0 | 2 | 0 | 3 | 0 | 0 | * | — | — | — | — | — | — | — | — | — | — | — | — | — | 169 |
| 5 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 99 |
| 6 | 0 | 0 | 2 | 3 | 0 | 0 | 12 | 0 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * | — | — | 129 |

* Denotes death of females.

Average number of eggs for each female, 140.

to some extent by the much lower temperature conditions. These females were supplied with sugar-syrup for food. The table on p. 405 shows the egg-laying record and life of each female. These figures are not of very great value, as they only deal with a limited number of individuals, and have not been duplicated or carried out under more normal surroundings. However, they show that the females will breed and oviposit at a temperature ranging from 50° to 60° F., also that under certain conditions the egg-laying period may extend in a somewhat irregular fashion over a considerable number of days, and that the life of a female may last well over a month.

How these results would compare with what actually takes place in the field it is not yet possible to say.

The fact that larvæ in all stages of growth, eggs, pupæ, and adults, may be found in the same field and at the same time throughout the summer months tends to show that possibly the egg-laying period may last some little time.

*Incubation Period and Hatching of the Egg.*—During the summer months the egg stage lasts from three to four days, but in late autumn and winter it will be extended to eleven or twelve days.

A short time before hatching the egg becomes dark in colour owing to the head of the larva showing through the shell.

When ready to emerge from the egg the young boll worm bites vigorously at the shell until it makes a hole through it, generally at the base of the primary crown. The hole is gradually enlarged until it permits of the easy passage of the head. This having been accomplished, the larva crawls out free of the shell. The process of eating a passage through the shell is not continuous, rests being taken at intervals; the young caterpillar appears to find it hard work to bite through the main vertical ribs. The period occupied from the time the boll worm first commences to bite at the shell until it finally escapes varies in length; sometimes it only takes about twenty minutes, at others it may be prolonged to fifty minutes.

The empty egg-shell is dull transparent white, and generally keeps its shape; the crown and upper part may or may not be left attached to the lower portion. The newly hatched boll worm does not appear in any case to devour the shell which it has just vacated.

### Larva or Worm Stage.

*The Young Larva.*—When first hatched the young boll worm is about 1·4 mm. in length and of a pale yellowish colour, with a conspicuous bluish-green or bluish dorsal line, which disappears after a short time. The head is black or very dark brown, shiny, and furnished with a number of long, fine, and pale-coloured hairs. Thoracic shield brown. The body is provided with numerous fine pale hairs, which are of considerable length, especially on the anal segments.

After it has escaped from the egg the boll worm wanders about for a short time, and finally proceeds to bore into a boll, square or terminal bud.

*Description of Mature Boll Worm* (Plate II, Figs. 3 and 4).—The mature larva or boll worm is about 15 mm. or slightly more in length; the anterior part of the body is rather thick-set, but it tapers towards the anal end. The "hunched-up" appearance is most marked when the boll worm is at rest. The general colouring varies from reddish-brown (often with a purplish tinge), with pale brownish-yellow and orange markings, to pale bluish-green and dull olivaceous-green, with similar adornments. The body is furnished with numerous fleshy spikes, which give the larva a very characteristic appearance.

The head is highly polished, black or very deep brown, shaded with a paler tint of the same colour; there is a prominent median transverse yellowish band, which gradually merges into brown at the edges. Antennæ pale. Inverted V-shaped mark, fine and dark. The head is provided with a small number of short, fine, and pale hairs.

The thoracic shield is shiny, yellowish in colour, with a median transverse, shallow, but broad groove, coloured dark brown; posterior edge of shield also of the same colour. The shield is cut longitudinally by a pale line, narrow anteriorly, broadening out posteriorly; along the edges there are several small black punctures, also similar markings on the posterior margin of the shield. The latter is furnished with four pairs of long yellowish hairs, shaded at the base, which arise from small darkish brown tubercles arranged as follows: four bordering the anterior margin, one placed each side, immediately behind the median transverse groove near the lateral margin, and one each side of the median longitudinal pale line, near the posterior edge of the shield.

On each of the second, third, and fourth segments there are two pairs of prominent fleshy spikes—two median and two lateral. On the second and third segments the median pair situated each side of the dorsal line are the largest, and dark in colour; the lateral ones are pale and slightly shorter. Both pairs on the fourth segments are pale.

These fleshy spikes are piliferous, bearing large numbers of short fine hairs, which are dark on the dark-coloured spikes, and pale on the others. From the apex of each spike there springs a very long pale hair.

The base of each of these piliferous prominences is surrounded by a patch of bright orange colour. On the second, third and fourth segments, between the median spikes and immediately each side of the dorsal line, there is a small brownish tubercle, from which arises a short fine hair, dark at the base, pale at the tip. There is also a similar tubercle between the median and lateral spikes, which is surrounded by a blackish area. There are several short hairs near the base of the lateral spikes on segments three and four.

On each of the segments from five to ten there are two median and two lateral piliferous fleshy spikes, but they are less conspicuous than those on the anterior part of the body. Each is surrounded at the base by an orange-coloured area, which is more marked in the case of the lateral than of the median spikes; around the latter it is frequently obscure or absent, especially posteriorly. The spikes themselves on this part of the body are sometimes pale orange in colour. On the fifth and sixth segments there are four prominent blackish or dark brown spots; on the posterior edge of these there is a small tubercle which bears a short tapering hair, dark at the base, paler towards the tip. On the seventh segment the median spots are, as a rule, obscure; the lateral ones prominent, but not nearly so clearly defined as on segments five and six. On the eighth segment all four are conspicuous; on the ninth and tenth the lateral spots are fairly well marked, the median pair pale and obscure in comparison. The tubercles are present in each case. On segment eleven there are three pairs of fleshy prominences—median, lateral, and sub-lateral; they are more rounded conical in shape, and the covering hairs are less numerous and more spike-like. The apical hairs are long, stout, and dark at the base, finer and pale at the tip. Anterior to the median pair of prominences, and each side of the dorsal line, there are two brownish tubercles which bear a short hair. On segment twelve there are six fleshy prominences, and in this case the two tubercles are represented by similar but smaller structures.

The anal shield on the thirteenth segment is dark brown or blackish, with sinuous margin. Around the latter are placed rounded conical prominences, covered with short spike-like hairs, and bearing at the apex a long, rather stout, and dark-coloured hair. On the central area of the shield there are a pair of similar but smaller prominences.

Below the anal shield there are two stout projecting fleshy spikes, which are covered with numerous stiff hairs, and furnished at the apex with a long hair.

The spiracles, which are oval, black, ringed with black, are situated in a line with and anterior to the lateral row of fleshy spikes, with the exception of the spiracle on the fourth segment, which is below. There is a sub-spiracular line of hairs, except on the second and third segments. Below these, and almost ventral, there is another line of hairs which, on segments one to three, arise from two tubercles, large and small, placed side by side; on the fourth and fifth segments these are represented by a fairly conspicuous fleshy spike. Posteriorly they are very much less prominent.

The first three segments of the body are, as a rule, pale, frequently pale bluish-green. Laterally the abdominal segments are dark reddish-brown, sometimes having a distinct purplish tinge. On the fifth, sixth, and eighth segments this dark colour extends over from each side and meets in the central line of the body. The dorsal area on the seventh and ninth to twelfth is pale yellowish-white, shaded with pale brownish-yellow. The ventral surface is a pale and rather dull bluish-green or dull olive-green. Some larvæ are almost entirely of the former colour. Others are more of a pale olive-green, but in all cases the dorsal area on segments seven and nine to twelve is paler. The dorsal line is slightly darker and fairly well marked.

The thoracic legs are pale, shaded with dark brown and smoky black, armed with strong pale brown claws. Abdominal feet and claspers same colour as venter, furnished with crescent-shaped series of pale brown hooks. The whole surface of the skin is covered with very minute hairs.

*Length of Larval Life.*—During the summer months the larval stage lasts about a fortnight, but in the autumn and winter months, when the temperatures are lower, growth takes place at a much slower rate, and this period is very considerably prolonged.

## Pupa Stage.

*Situation and Formation of the Cocoon on Cotton.*—When mature the boll worm leaves the boll on which it has been feeding and spins a boat-shaped cocoon, either between the side of the capsule and the involucre, or between two of the involucral bracts, or in any convenient fold of the latter. The cocoon is not necessarily made on the boll which the larva has vacated on reaching full growth, as it is not uncommon to find one on a boll which has not been attacked. The boll worm in many cases evidently wanders about the plant before finally settling on a spot in which to pass the pupal stage. Very often, on account of the drying up and contraction of the involucre, the cocoon becomes loosened, and may be finally dislodged altogether and fall to the ground owing to the disturbance of the cotton plants by wind.

Occasionally the cocoons are attached to the stem or a dead leaf, and sometimes the boll worm crawls down the stem of the cotton plant, and attaches its cocoon to the latter just below the ground level.

Mr. Fletcher[1] states that they also enter the cracks in the soil to pupate, and that they spin their cocoons on the under side of the leaves and weeds growing amongst the cotton. So far Mr. Willcocks has not been able to find them in this position. What proportion of the larvæ pupate in these last-named situations is not known, but it will probably be found that the majority pupate on the plants. One would expect this to be the case from the nature of the cocoon.

*Situation of the Cocoon on other Plants.*—In the case of tehl (*Hibiscus cannabinus*), the cocoons are spun between the seed capsules and the stem, or between two contiguous fruits, and occasionally on the involucral bracts. On the garden hibiscus (*Hibiscus rosa-sinensis*) they may be found on the stem in such places as the fork of a branch, or under a piece of loose bark, etc.

*Description of the Cocoon* (Plate I, Fig. 18).—The cocoon is somewhat boat-shaped, but it varies slightly in form, according to the position in which it has been made. The end at which the head of the pupa is situated is blunt, and consists of two lips, which are tightly drawn together with silken strands; they can, however, be forced apart easily by a slight squeeze between the finger and thumb, and also by the moth itself when it is ready to emerge. These lips turn outwards slightly and form a ridge, which projects at the apex into a small silken process; this is more marked in some specimens than in others.

The silk of which the cocoon is made is very closely woven and felt-like in texture; in colour it varies from white and dirty cream to pale and dark brown. There are, however, two coats of silk, which can be easily separated, and it is only the outer one which is dark-coloured; the inner is pale, often white, with a pearly lustre.

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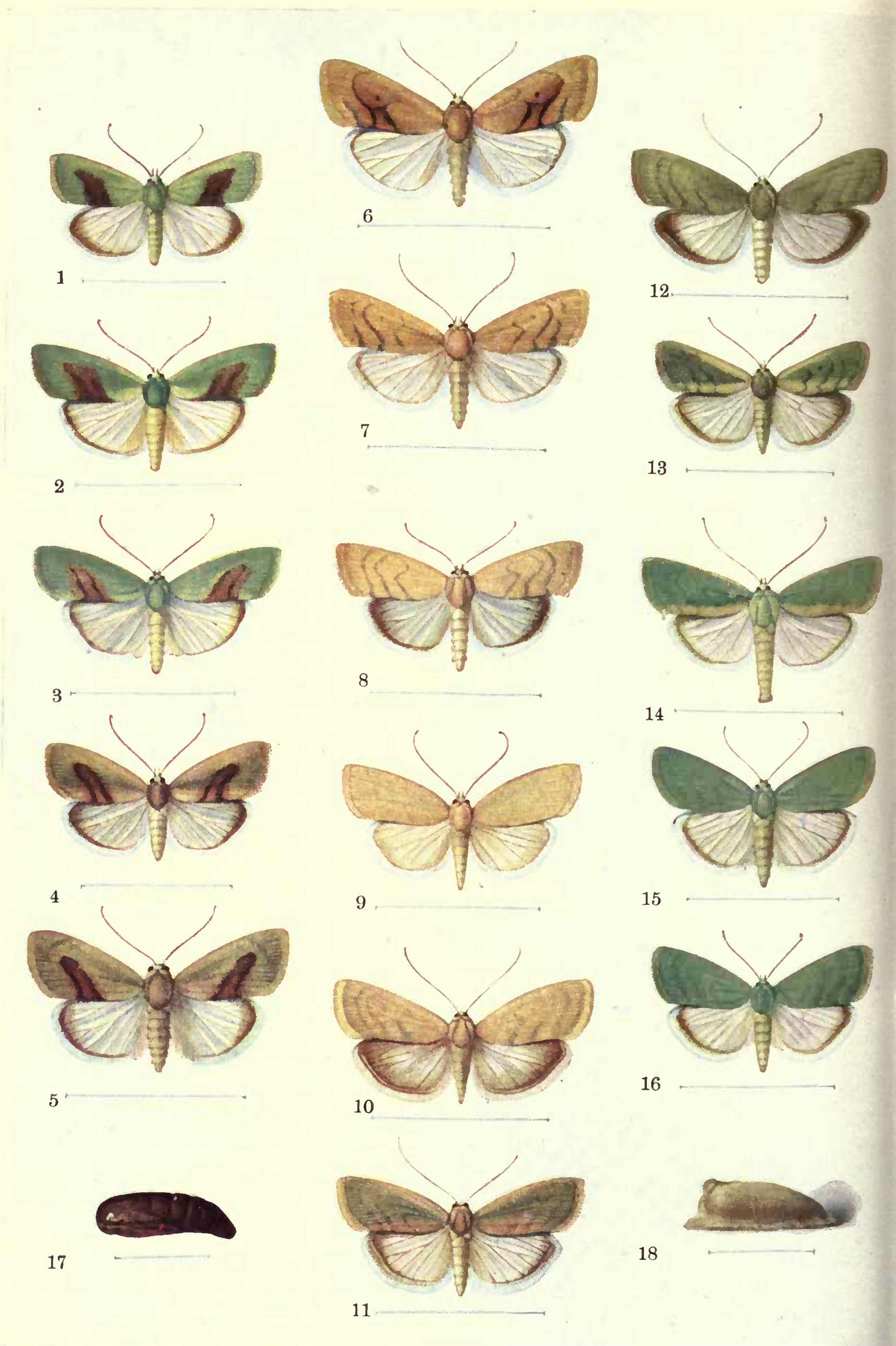
[1] "Notes on some Egyptian Insect Pests," p. 65, Bombay, 1905.

The dark brown type is very difficult to see when spun on the dried-up involucre of a cotton boll, and more especially when on the tehl plant, as it almost exactly matches its surroundings.

*Description of the Pupa* (Plate I, Fig. 17).—Length 9 mm. to 11·5 mm. Head, wing, and leg cases light yellowish-brown. Thorax dull blackish, with a purplish tinge at the sides; in some specimens the general colour of this part of the body is distinctly dull purple, as it is also on the empty pupa case. There is a distinct median carina on the thorax, the surface of which is much roughened, the rugosities being in the form of an irregular reticulate pattern.

On the first four segments of the abdomen the dorsal surface is of a dull purplish colour, median segments paler, shading to yellowish-brown at the sides. Tip of the abdomen dark and bluntly rounded. Dorsal surface roughened. Ventral surface pale yellow, sometimes suffused with a greenish tinge. On each side of the fifth abdominal segment posterior to the spiracle there are a number of small brown points which stand out prominently from the sides. These are arranged in a more or less linear area, which is widest in the middle. On each side of the last segment of the abdomen, and placed vertically, there are generally three well-marked tooth-like projections, the one nearest the dorsum being the most prominent, and a series of sharp-edged ridges below them. Both the teeth and the ridges appear to be variable in number and distinctness, but in any case the tooth-like projection nearest the dorsum is present and conspicuous.

*Length of the Pupal Stage.* — During the summer months the pupal stage lasts from ten days to a fortnight. In the late autumn and winter months it is very considerably prolonged. Larvæ which pupate at the end of December or in January may remain in this stage for two months or slightly more. Some boll worms which pupated in the laboratory in January, 1904, gave rise to the adults early in March after a quiescent period varying from thirty-five to fifty-two days.




H. KNIGHT, *Pinxit.*

FORMS OF EARIAS INSULANA, BOISD.

1—3. var. *semifascia*, Warren.
7, 8. var. *anthophilana*, Snell.
14. var. *ochreimargo*, Warren.
15, 16. *E. insulana*, Boisd.
17. Pupa.
18. Cocoon.

Other figures represent intermediate forms.

### Perfect Stage.

The moth (Plate I, figs. 1-16) has the head, thorax, and fore wings, bright pea-green, chrome-yellow, or brownish, the latter crossed by three more or less distinct dark lines, each angled acutely above the middle. The hind wings are semi-transparent white, with pale fuscous margins and apex. The abdomen above is silvery-grey, and the under surface white. The fore-wings frequently have patches of purplish or brown near the middle. During summer and early autumn the green forms are in greater numbers, and in the latter part of the year these are comparatively rare, being replaced by the yellow and brownish forms. The patched form seems to occur at the transitory period between the green and yellow forms. This suggests that a seasonal dimorphism exists, which is usually an indication that a protective colouring is necessary for the insect's preservation. In this case the green insects would be inconspicuous when settled on the green foliage, and the brown and yellow similarly so when upon withered leaves, etc.

The various forms are described and figured by Mr. Storey, Assistant Entomologist to the Ministry of Agriculture, in vol. iii, part ii, of the *Agricultural Journal of Egypt*. This illustration is reproduced as Plate I with this paper.

The perfect insect measures about 22 mm. in expanse, and the body is about 9 mm. in length.

It is curious to note that it has been frequently found in desert places far removed from cultivation. Mr. Willcocks mentions that Mr. Graves, of Cairo, found specimens near Moses' Well (opposite Suez) and in Wadi Hof, Helwan, about four miles from cultivation. The species is common in Kharga Oasis in the Western desert, having probably been introduced with cotton or bamiah.

*Habits.*—With regard to these, Mr. Willcocks says: "During the daytime the moths frequently shelter between the involucre and the boll, and they may often be found at rest on a leaf exposed to the full glare of the sun.

"Sometimes they may be taken *in coitu* in the latter situation. Rough grass and weedy growths near the cotton fields also form day retreats for the adults. When at rest the wings are tightly folded into the sides of the body with one fore wing slightly overlapping the other, so that the insect appears more or less wedge-shaped. When they settle to feed the wings are held in a 'tectiform' position over the abdomen.

"As soon as it becomes dark the boll worm moths may be seen on the wing, their object being to feed and oviposit. They fly with a rather slow and wavering flight.

"Certain flowers appear to have a strong attraction for them. During the last week in November, 1905, great numbers of the moths were observed flitting about a bed of chrysanthemums, from the disc flowers of which they were busily engaged in sucking out the nectar. During the day they concealed themselves amongst the petals, as many as four or five being present on a single flower-head."

The species has been recorded from the following localities:—

Europe.—Southern Spain, Sicily, Crete.

Africa.—Throughout North, East, and South, and recorded from Northern Nigeria in the West, Canaries, Madagascar, and Mauritius.

Asia.—Syria, Baluchistan, India, Burma, and Siam.

Australasia.—Queensland.

The food of the larvæ appears to be limited to plants belonging to the Order Malvaceæ, among which it has only been found upon the following species in Egypt: Cotton (*Gossypium* spp.), bamiah (*Hibiscus esculentus*), tehl (*H. cannabinus*), and garden hibiscus (*H. rosa-sinensis* and *H. mutabilis*). A distinct preference is shown for cotton in Egypt, although in India bamiah seems to be more attractive, and for this reason has been used as a trap in that country.

It is the opinion of several entomologists and other careful observers in Egypt that more damage is usually done to the cotton crop by the boll worm than by the cotton worm, notwithstanding that the latter is so much more conspicuous in the fields.

*First Records of* E. insulana *in Egyptian Cotton Fields.*

In spite of the fact that the presence of boll worms in a cotton field is much less conspicuous to the casual observer than that of cotton worms, the former were recorded as attacking cotton several years previous to the latter. The credit of having first drawn attention to the pest belongs to Joannovitch Bey, who studied the habits of the insect from 1865 to 1872, and published a record of his observations in a paper under the title of "Description de l'insecte ravageur du coton en Egypte" (*Bulletin de l'Institut Egypt.*, 1873).

In 1871 a Commission was formed, to which Joannovitch Bey presented a report. The insect was sent for identification to Boisduval, who described it as a new species, which he placed in the genus *Eriophaga*, and named *Eriophaga gossypiana.*[2] Boisduval pointed out in his description that the species was distinct from his *Tortrix insulana,*[3] but later authorities do not agree that this is the case, and the last specific name takes precedence, and has been adopted throughout scientific literature dealing with the insect.

Important though the boll worm is for consideration in respect to cotton in Egypt, very little was written concerning it during the subsequent thirty years, the contribution by Innes Bey in 1884 (*Bulletin du Comité Agric.*, No. 1, 1884), a report by Mr. Williamson Wallace, presented to the Commission of 1895 (which does not appear to have been included in the general report of the Commission), and a communication by M. Dechevalerie (*Bulletin de l'Institut Egypt.*, May, 1898), comprising nearly the whole literature with reference to it produced during that period in Egypt. In 1905 Mr. F. C. Willcocks contributed a very complete description, including all that was known up to that time concerning the boll worm, and from this work I have already given extracts.[4] In 1906

[2] *See Bull. du Comité Agric.*, No. 1, Avril, 1884, Ann. B., p. 29, le Caire.

[3] Boisduval.—*Faun. Madag.*, p. 121, pl. 16, fig. 9, 1833.

[4] Willcocks, F. C.—*Year-book of the Khediv. Agric. Soc. for* 1905, pp. 57-91.

an article based upon the writer's report to the Secretary of State for the Colonies of Great Britain appeared in the *Bulletin of the Imperial Institute*, which dealt with the insects which attack cotton in Egypt,[5] and a reference was again made in an account prepared by the writer upon insect and other cotton pests and the methods suggested for their destruction, which appeared in the *Bulletin of the Imperial Institute* in the following year.[6] An article upon the subject of the methods employed in Egypt and elsewhere to check the ravages of the cotton boll worm appeared in the *Agricultural Journal of Egypt* in 1911.[7]

*Commission of* 1910.

In the report of the Cotton Commission, which was issued in 1910, reference was chiefly made to the cotton worm among the pests which infest cotton, but a few references occur which show that it was recognized that the boll worm was responsible for considerable damage. On p. 5 of the report we find: "La production cotonnière totale de l'Egypte n'a pas augmenté dans la même proportion que la superficie plantée, et en 1909 plus particulièrement, il y a eu une chute brusque dans le rendement moyen au feddan. Si l'on étudie la situation particulière à la Haute Egypte, on constate qu'à part l'année 1905 où les chenilles de la capsule commirent d'énormes dégâts le rendement au feddan n'y a pas suivi une marche descendante. L'année 1909 marque cependant une chute accentuée."

The Commission recommended two methods to be employed against the boll worm attacks, one of which was the production of an early maturing variety of cotton, and the other the promulgation of a decree making the destruction of all malvaceous plants necessary by the end of December. The Commission also considered the application of the system of moth trap,

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5 "Insects which attack Cotton in Egypt" (Dudgeon), *Bull. Imp. Inst.*, vol. iv, 1906, pp. 48-50.

6 "Insects and other Cotton Pests and the Methods suggested for their Destruction" (Dudgeon), *Bull. Imp. Inst.*, vol. v, 1907, p. 145.

7 Dudgeon, G. C.—*Agric. Journ. of Egypt*, vol. i, 1911, pp. 40-43.

introduced by Messrs Andrés and Maire, for the capture of the boll worm and cotton worm moths, and a large amount of work with these appliances was subsequently undertaken by Mr. F. C. Willcocks, with the result that they proved to exercise an insufficient deterrent effect upon the propagation of the insects.

*Cotton Worm and Boll Worm Commission in* 1912.

In 1912 a Commission was formed at the instigation of Lord Kitchener to make a complete study of the cotton pests, and the Sub-Committee appointed by the Commission is still engaged in the investigation. In the meantime another pest has appeared which has placed the common boll worm rather in the background, and which has given evidence of causing a diminution in the numbers of the original insect by the substitution of itself in its place.

The efforts which are now being made to destroy this new pest, the pink boll worm or seed worm, can almost all be made applicable to the Earias boll worm also, and the modification of the boll worm decree rendering it compulsory to pick off and burn all bolls after the last cotton picking is designed to be effective against both pests equally.

*Estimation of Damage done by the Common Boll Worms.*—It has always been a matter of great difficulty to estimate the damage done to the cotton crop by the larva of *Earias insulana.* It is, in fact, only possible to give a comparative estimate of the effect each year, but, as the degree of destruction is almost wholly dependent upon whether the crop is an early or late one, it is nearly safe to predict that damage will be great when the crop is late and slight when it is early.

The reason for the above is that the generations of boll worm multiply rapidly throughout the year, being at their minimum in the winter or early spring, when the food plants, cotton and hibiscus (bamiah and tehl) are most scarce, and increasing in each generation as these plants again become plentiful, until, in the month of October, the greatest quantity of food is available and the largest number of boll worms are able to find sustenance.

It is often supposed by the agricultural population that the prevalence of fogs and cold weather increase the numbers of boll worm. This is only indirectly the case, as we find that the fogs and mists retard the maturity of bolls and thereby assist the development of boll worms, in addition to which a condition of subdued light is produced, which is favourable to the awakening of activity in the feeding larvæ; bright sunlight being a strong adverse condition.

*Effect produced by an Attack.*—The effect of an attack of Earias boll worm upon the cotton plants is evidenced in several ways. In the earlier generations, when no boll flowers or buds are present on the cotton plant, the young worm attacks the terminal shoots of the plant, each worm tunnelling into the succulent shoot near the top and eating a passage down the centre of the stem until it reaches the harder and more woody parts, when it leaves the stem to attack a fresh shoot. A terminal shoot which has been attacked in the manner described withers and soon changes to a dark colour, and if cut off at a point a little below the withered portion the living boll worm may be found within the stem.

As soon as the buds appear upon the plants the worms attack them in preference to the shoots, and the presence of a boll worm in a bud is manifested by what is termed "flaring" in the United States, where a similar result is produced by the boll weevil, an insect, fortunately for the present confined to the Southern cotton states in America. The appearance of a flared bud differs from that of a healthy one in that, in the flared one, the involucres or leaf-like coverings of the bud open widely, exposing the bud, which in a normal case would be hidden by them. In some cases the flared bud falls to the ground, its vitality being injured by the growing connection with the stem becoming interrupted or atrophied. Although the bud has been destroyed in this way the boll worm rarely suffers by the fall, leaving the fallen bud to attack a fresh one.

Boll worms are frequently found in the flowers, feeding upon the pollen and reproductive organs, thereby rendering the flowers themselves sterile.

When attacking a boll the minute larva lives for the first few days after its emergence from the egg in the outer shell of the boll, producing a small circular hole which it enlarges as it proceeds into the boll itself. When a boll worm has entered a boll it protects itself from disturbance by other insects or parasites by discharging a quantity of more or less moist excreta which effectually prevents the entry of any other insect by the passage which has been made by the larva.

The boll worm may confine its attack to one cell only in a boll, or it may destroy all three cells, or even more than one boll. If a medium-sized boll be attacked it frequently dies and dries up without becoming detached from the plant, but in such a case the plant itself has ceased growing, otherwise the boll would most probably fall to the ground. When the bolls die and remain attached to the plant they become a reddish-brown in colour, and are known to the native cultivators as "nabroon."

Large bolls when pierced at a period of semi-maturity open prematurely, and by the exposure of their moist, incompletely developed lint render themselves liable to the attacks of saprophytic fungi, which completely destroy the value of the lint by covering it with black spores.

*Prolongation of Metamorphoses in Winter.*—As the autumn advances and the weather becomes colder the larval stage of the boll worm is prolonged, and after all the valuable cotton has been picked the cotton plants are pulled up and stored for fuel. During this storing period boll worms remain inside the drying bolls attached to the plants, feeding upon the seeds until, by reason of the contraction due to the drying up of the contents, the worms, if immature, die, or if fully mature emerge in the usual way to pupate. For this latter change they secrete themselves in the dried and shrivelled involucres and leaves or upon the stems and form a smooth cocoon of brownish or buff-coloured silk in which to undergo the change into the pupa state, during which time they require no further nourishment. In this stage they remain until the warmer weather causes them to be transformed into moths, when they emerge, either to remain dormant for a further period, or to fly off to deposit eggs on the food plants of their coming generation, such food consisting of the shoots emanating from cotton, bamiah, or tehl, which have been left in the ground. Upon these the females lay isolated eggs in the most protected positions possible, and the larvæ emerge, after a further dormant egg period, to carry on a precarious existence upon the limited food supply available.

*Probable Vitality of Generations.*—During the earliest brood it is probable that only 10 per cent. of the eggs laid produce moths for the next generation, but it may safely be reckoned that 50 per cent. of each of the subsequent ones survive.

From experiments which have been made by Mr. Willcocks, and which have been previously quoted, the average number of eggs laid by a female moth in December and January is determined as 140, and the time occupied by a female for the complete oviposition at this season varies from eight to forty-four days. On the other hand, a female kept under observation by Mr. Willcocks in September continued laying for five nights only, but deposited 233 eggs.

In order, therefore, to give some idea of the rate of propagation of the Earias boll worm throughout the year, the following calculation is considered a fair one.

Assuming that the females in the first generation lay 140 eggs each and in the following generation 200 eggs, an estimate of the production in the fifth generation (October) from one pair of moths, the female of which laid in January, can be arrived at as follows:—

1 pair produces 140 eggs, of which 10 per cent. = 14 produce moths.

7 pairs (14 moths) produce 200 eggs each = 1,400, of which 50 per cent. = 700 produce moths.

350 pairs (700 moths) produce 200 eggs each = 70,000, of which 50 per cent. = 35,000 produce moths.

17,500 pairs (35,000 moths) produce 200 eggs each = 3,500,000, of which 50 per cent. = 1,750,000 produce moths.

One female moth which laid in January would therefore be responsible for the production in October of 3,500,000 boll worms, of which, at a very moderate estimate, 1,750,000 would survive to become mature.

Some conception of the damage resulting from the preservation of each pair of boll worm moths in the early months of the year can be obtained from this.

*General Disregard of the Importance of the Boll Worm.*

Scientific entomologists and those who have made a study of the insect pests on cotton are convinced that the cotton worm is of minor importance in comparison with the boll worm; yet, although proposals have been constantly invited by the Cotton Worm and Boll Worm Commission for remedial measures against this pest, few suggestions have been received and none have proved of any practical value. All the investigations in connection with this pest have been made by the Scientific Staff of the Ministry of Agriculture and the members of the Sub-Committee of the Commission, and nearly every satisfactory proposal for remedial measures has emanated from the Ministry or the Commission itself.

*Some Influences on the Activity of Boll Worms and Methods of Control Indicated.*

In connection with many lepidopterous insects it has been found that the greatest activity is shown in their attacks upon plants at times when the latter are not exposed to bright sunlight. Very many lepidopterous larvæ will not feed except in positions where they are protected from the direct rays of the sun, therefore in most cases the depredations are done at night, in cloudy weather, or in positions where the greatest amount of shade is obtainable. Although demonstration of the utility of the defoliation of the cotton plants as a beneficial measure for boll worm attacks has not been made, the success which is said to attend this operation in connection with the boll weevil in the United States of America is some assurance that a similar result might be expected in the case of the Egyptian boll worm. Defoliation is effected in Texas by attacks of a cotton worm, *Aletia argillacea*, the advent of which is welcomed in the boll weevil districts, though this defoliating cotton worm is destroyed in other localities. The effect of the defoliation is not only to kill the boll weevil larvæ in the affected bolls by exposure to the sun's heat, but to accelerate maturity of the bolls themselves. In Egypt the experiment of defoliation has yet to be made, and could be done by hand without injury to the plants.

A member of the Commission drew attention to the fact that, as it was stated that the terminal shoots of cotton plants were attacked by boll worms before the buds and bolls were produced, an addition might be made to the existing law to compel the picking of infested shoots at the time when the people were employed in the fields for the collection and destruction of the eggs of cotton worm (*Prodenia litura,* Fabr.). To add such clauses to a law which is promulgated to deal with the ravages of cotton worm only would but create a confusion, but a clause was inserted in the instructions given to cotton worm inspectors to draw attention to the fact that the wilted and withered terminal shoots on cotton plants would be found to contain boll worms and to direct that these should be picked and destroyed together with the leaves which contained cotton worms or the egg masses.

When buds have been attacked by the pest and have become detached from the plant due to the suppression of their vital connection with the stem which bore them, the boll worm usually leaves the fallen bud to search for a fresh one. During this time the larva exposes itself to the greatest peril, being a ready prey to carnivorous beetles (Carabidæ) and to the intestine infesting larvæ of the Ichneumonidæ and Braconidæ, the adults of which hover about cotton plants and patrol leaves, buds and bolls in search of the boll worms, in whose bodies they deposit their eggs. A short account of these parasites is given in another part of this paper.

Some of the Braconidæ, among which the most important one found in India destructive to the Earias boll worm is *Rhogas Lefroyi*, Dudgeon and Gough, were introduced into Egypt in 1912 by the Egyptian Government. Great difficulty was experienced in transporting the parasite mentioned from Bengal to Egypt in a living condition, and just when success had been attained in this direction the value of the introduction was depreciated by the discovery of a nearly allied indigenous Braconid, named *Rhogas Kitcheneri*, Dudgeon and Gough, in the province of Beni Souef, in Upper Egypt. This little parasite has been found commonly in the first locality and shows signs of spreading. The experiment, which was conducted in India by Professor Maxwell Lefroy, in propagating the Rhogas parasite and introducing it into the fields infected with boll worm showed that the diminution in the percentage of attacked bolls was very large, but the difficulties of propagation on a large scale in the laboratory were so great that this scheme as a remedial measure seemed well-nigh impracticable. The transference of infected larvæ or the parasite pupæ to new localities to enable colonies of the parasite to establish themselves naturally promises to be of greater efficacy in Egypt. Operations in this direction are being undertaken by the Entomological Section of the Ministry of Agriculture.

The Rhogas or other Braconid parasites which may attack the Earias boll worm can only do so when the larva is feeding in the flowers, or when it has freshly commenced to perforate a boll, or when it is leaving one boll to reach another, or to pupate. During these short periods of exposure if the parasitic Braconid does not discover the larva the latter is apparently secure from its attack, as after having entered the bud or boll the entrance is quickly stopped by the excrement voided by the feeding larva. In India, where *Earias insulana* and *E. fabia* are both found attacking cotton, other Braconids occur infesting their larvæ, but it appears that none are furnished with sufficiently long ovipositors to penetrate deeply into the bore-hole made by the Earias nor have any means of reaching the larva in the boll. In consequence their attacks must be made in a similar manner to those of the Rhogas here referred to.

Having taken into consideration the fact that the Earias boll worm feeds upon a very limited number of plants, all belonging to the natural order Malvaceæ, of which cotton, bamiah and tehl are almost the only widespread and plentiful examples in the country, Mr. Willcocks recommended in 1906[8] that certain preventive

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[8] *Year-book of the Khediv. Agri. Soc.* for 1905, p. 87.

measures should be introduced. Mr. Willcocks maintained that tehl and bamiah should always be pulled up by the roots, never cut, as the latter would only induce new growth from the roots, which would yield a sufficiency of food for the next generation of boll worms. Cotton wood, he urged, should not be allowed to remain in the field until January, March, and April, as this was certain to provide a material help to the boll worm. When the cotton wood was cleared he recommended that it should be used for fuel as quickly as possible, in order to destroy the boll worm pupæ which might be upon it.

*Legislation regarding Cotton Boll Worm.*

The outcome of Mr. Willcocks's recommendation was the promulgation of a law (No. 27 of 1909) which was originally designed with the chief object of the elimination of all growth of bamiah, tehl, and cotton for a definite period, but which, as it was finally passed, permitted the continuous cultivation of ratoon cotton (okr) in some districts, and was found almost unworkable in connection with the rest of the cotton area, owing to the fact that cotton plants were permitted to be cut instead of being pulled up, and were frequently found growing as strong plants when the succeeding crop, berseem or wheat, was cut in the next spring.

After much representation of the evils attached to the cultivation of okr or ratoon cotton this cultivation was regulated by law at the instance of the Department of Agriculture (No. 19 of 1912). It was made compulsory by this new law to uproot or cut below the surface of the soil all plants of cotton, bamiah, or tehl in such a manner that they could not sprout again. This obligation with respect to the greater part of Egypt was executable before December 15 of each year, and a few districts only in the north were permitted to extend the period until January 15. The cultivation of okr or ratoon cotton was only permitted in certain districts if a Ministerial Arrêté was published to this effect before March 1 in the year preceding.

There was a great improvement occasioned by the enactment of this law. The cultivation of ratoon cotton ceased and most of the cotton plants were pulled up previous to the date mentioned. Cultivators in Upper Egypt still continued to cut their cotton after having sown berseem (clover) in the standing crop, and volunteer cotton was frequently found in the late spring in consequence. Insufficient attention also was paid to the destruction of bamiah and tehl.

Nevertheless a beneficial effect was apparent in almost every instance where a comparison was made between the bolls attacked by Earias in 1912 and those from the same localities in 1913 (*see* Appendix I). It is true that in some cases more bolls were attacked by boll worms than before, but upon examination it was found that the depredator was not Earias, but the new pest, the pink boll worm.

In consequence of the rather sudden appearance of the pink boll worm in Egypt, a proposition was made early in May, 1913, by myself, in my capacity as Member-Reporter of the Cotton Worm and Boll Worm Commission, to the said Commission that a clause might be inserted in the existing Boll Worm Law No. 19 (1912) to the effect that it should be made compulsory to detach and destroy all bolls upon cotton plants immediately after the last picking of cotton. This measure would be equally efficacious for the destruction of hibernating Earias boll worms as for the other species.

The Commission having at its meeting of May 8 favourably entertained the above proposition, submitted the same to the Government, with the recommendation that the proposed necessary steps be taken for the eradication of the pests.

In a subsequent letter, dated July 3, to the Government the Commission expressed a wish that it be made compulsory for cultivators to detach immediately after the last picking all the bolls remaining on the cotton plants before the removal of the plants ordered by Law No. 19 (1912).

Further, the Commission was of the opinion that the destruction of the worms in the bolls detached in the above way could be done by their submission to the heat of ovens. This system would have the double advantage of killing the worms without entirely damaging the cotton which villagers might still be able to obtain from the bolls in question.

With reference to the above, a letter, dated August 9, 1913, was received from the Council of Ministers to the effect that the Council having considered the above proposition found it was opportune to take into serious consideration the wish expressed by the Cotton Worm and Boll Worm Commission.

Unfortunately, at that time it was not possible to get any legislation passed owing to the delay in the formation of the new Legislation Assembly, to whom it was necessary that all laws should be submitted for discussion. Some action, however, was deemed necessary, as the depredations by both species of boll worms were severe, and if no steps to ameliorate the condition were undertaken the result might mean a still further loss in the following season.

The proposals for a law were submitted by the Ministry of Agriculture to the legal advisers of the Government, but owing to the change in the constitution of the country the law was not passed in time for any compulsory action being adopted in the winter of 1913. Urgent steps were, however, taken to get the measures recommended in the law, to be carried out administratively pending the passing of the law itself. To this end the Ministry of the Interior issued instructions in the winter of 1913 to the Governors of Provinces that the cultivators should be induced by administrative measures to pick off and destroy by fire all bolls left on cotton plants after the final picking of the crop. Great difficulty was experienced in this work, as without the aid of the law the provincial authorities were severely handicapped. In a few districts a large number of bolls were picked and destroyed, but in others practically none. The law of which the draft follows was passed and put into force in 1914. The political situation interfered somewhat with the strict observance of the articles at as early a date as was desirable, but eventually stringent action was taken which should be followed by good results.

The law is as follows: —

## LOI No. 4 DE 1914.

Loi modifiant la Loi No. 19 de 1912 portant les Mesures à prendre pour la Destruction du Ver de la Capsule.

Nous, Khédive d'Egypte,

Vu la loi No. 19 de 1912 portant les mesures à prendre pour la destruction du ver de la capsule du coton;

Sur la proposition de Notre Ministre de l'Agriculture et l'avis conforme de Notre Conseil des Ministres;

L'Assemblée Législative entendue;

Vu les délibérations de l'Assemblée Générale de la Cour d'Appel Mixte en date des 12 et 17 juin 1914, prises en conformité du Décret du 31 janvier 1889;

Décrétons :

### ARTICLE 1.

Il est ajouté à l'article premier de la loi sus-visée un troisième alinéa ainsi conçu :—

Chaque année, après la récolte, toutes les capsules encore adhérentes à ces plants devront être enlevées et brûlées.

Cette opération devra être exécutée, au moins quinze jours, avant les dates respectivement fixées ci-dessus pour chaque province, pour l'arrachage ou la coupe des racines des plants et dans tous les cas avant qu'il ne soit procédé à cet arrachage ou cette coupe.

### ARTICLE 2.

Il est ajouté à l'article 3 de la loi sus-visée un second alinéa ainsi conçu :—

En cas de contravention au troisième alinéa de l'article premier, les plants seront toujours saisis et brûlés, qu'ils aient été ou non arrachés ou coupés.

### ARTICLE 3.

Nos Ministres de l'Intérieur, de la Justice et de l'Agriculture sont chargés, chacun en ce qui le concerne, de l'exécution de la présenté loi qui entrera en vigueur à partir de la récolte de 1914.

Fait au Caire, le 20 juin 1914.

Pour le Khédive :
(Signé) H. RUCHDI.

Par le Khédive :
Le Président du Conseil des Ministres,
Ministre de l'Intérieur.
(Signé) H. RUCHDI.

Le Ministre de la Justice.
(Signé) SARWAT.

Le Ministre de l'Agriculture.
(Signé) I. SIDKY.

Suggestions were made by the Chief Inspector of the Ministry of Agriculture, Mr. A. T. McKillop, that cotton sticks might be economically made into charcoal, and demonstrations were given of the method of conversion.[9] It was maintained that if this were adopted it would overcome the difficulties in connection with the operation of picking of bolls, to be made compulsory by the law mentioned above, and would not completely destroy the cotton sticks, which are the chief form of fuel in a large part of the country. The loss in volume caused by the conversion of cotton wood into charcoal is compensated to some extent by the increased calorific value of the charcoal. The main advantage, however, would be that the boll worms remaining in the dead cotton plants as well as in the cotton bolls would be effectively destroyed. The neglect of the cultivators to make use of this suggestion made it imperative to carry through the law mentioned above.

Among the many measures proposed for the destruction of insect pests the experiments conducted in the Entomological Section of the Ministry of Agriculture under the direction of Dr. Lewis Gough call for special mention. Dr. Gough, as member to the Commission, submitted a note to the Committee pointing out that with relation to all the cotton pests the action of various insect maladies was under examination. Experiments have since been made with most of the diseases known to be fatal to insects, and with reference to the common boll worm it has been found that it is among those susceptible to attacks of the protozoan disease (*Microsporidium polyedricum*, Bolle), as well as the other diseases of silk worms. The Microsporidium disease, known also as "grasserie," is common among silk worms, and was introduced into Egypt in 1912, in which year a spontaneous outbreak occurred among cotton worms (*Prodenia litura*, Fabr.), which were very numerous in that year.

The rapidity with which this disease spread throughout the country and the subsequent effect on the appearance

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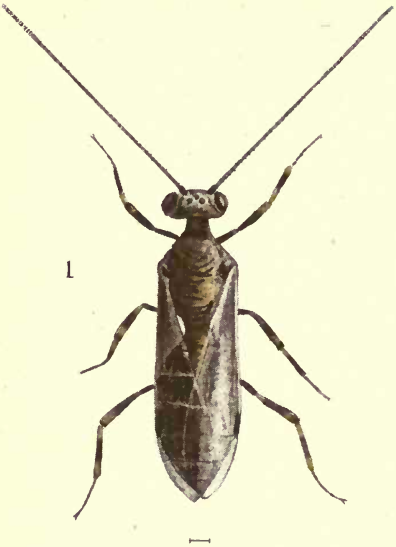
[9] McKillop.—*Agric. Journ. of Egypt*, 1913, vol. iii, part 2, p. 27.

1



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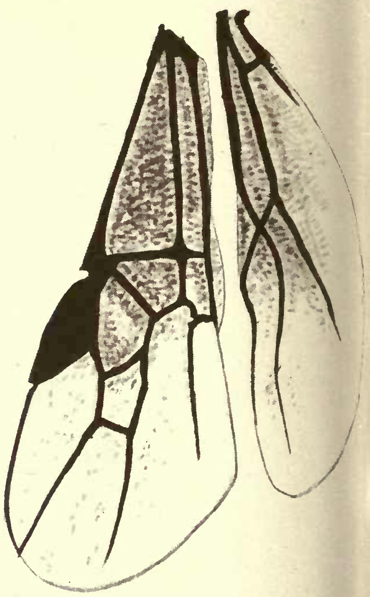

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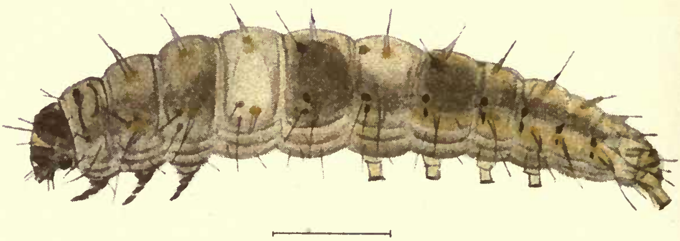

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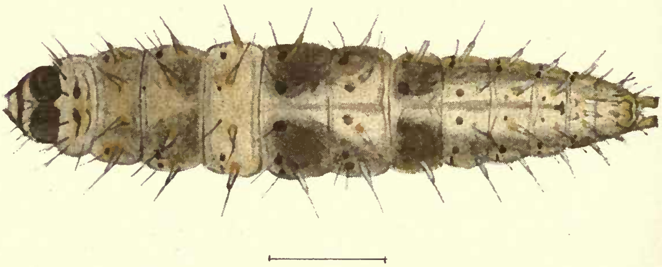

1. *Rhogas Kitcheneri*, Dudgeon and Gough. ♂ × 18.
2. Wings of *R. Kitcheneri* showing neuration. × 30.
3. Larva of *Earias insulana*, Boisd. (lateral view). × 8.
4. Larva of *E. insulana*, Boisd. (dorsal view). × 8.

of these insects in 1913 and 1914 is now of almost general knowledge in Egypt. The disease was found to be easily transmitted to Earias by removing them from the bolls and bringing them in contact with it, but from the larva's method of feeding inside the living bolls it was difficult to produce a general outbreak among boll worms. The same applies also to other contagious insect diseases as applied to the boll worm; the isolated interior feeding habits of the larva having been found up to the present the insuperable hindrance to infective control.

*Natural Enemies destructive to Earias Boll Worm.*

Reference has been made elsewhere to the insects which have been found attacking the Earias boll worm. Mr. Willcocks,[10] in 1906, referred to ants having been found eating holes through the cocoons of the boll worm and devouring the pupæ, but it was doubtful whether these accounted for very large numbers of boll worms, as the fields did not abound in ant colonies.

A small lepidopterous larva was also found by Mr. Willcocks attacking and devouring the pupæ; the species was, however, not determined. (There is some evidence to show that this may be an insect known as *Cryptoblabes gnidiella*, Mill, whose carnivorous habits have not been previously noted.)

A hymenopterous parasite belonging to the family Braconidæ was also found by the same observer. This was not common, and the perfect insects when emerged were found to belong to the species which was afterwards described under the name of *Rhogas Kitcheneri*, Dudgeon and Gough (Plate II, figs. 1 and 2).

Two specimens of another hymenopterous parasite were found inside the pupæ of boll worms. They were said to resemble one of the stages of a Chalcid, but it is possible they may have belonged to *Pimpla roborator*, Nees (*see p.* 431).

In the summer of 1912 the Government deputed the Entomologist of the Department of Agriculture to visit

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[10] Willcocks.—*Year-book of the Khediv. Agric. Soc. for* 1905, p. 85.

India to investigate the methods of suppressing the Earias boll worm in that country, and on the return of this officer a number of larvæ infected with *Rhogas Lefroyi*, Dudgeon and Gough, were introduced.

The introduction of these was, however, rendered unnecessary owing to the discovery a little later of an already acclimatized nearly allied insect, which has been described under the name of *Rhogas Kitcheneri*.[11]

The first recorded specimens of *R. Kitcheneri* were bred in October, 1912, in the laboratories of the then Department of Agriculture, from common boll worms from Beni Souef. The species has since been recorded from Menufia and Kharga Oasis. Further investigations will probably show that it occurs throughout the greater part, if not the whole of Egypt. However, although it was abundant in consignments of boll worms received from Beni Souef and Kharga Oasis, it does not seem to be generally common in the Delta.

Although the act of oviposition has not been actually observed in this species, the eggs are probably laid in the boll worms when they are entering or leaving a boll, or when they are near the entrances of their tunnels. As the ovipositor is only 5 mm. long, Rhogas cannot lay its eggs in larvæ which have made their way well into the bolls, as can *Pimpla roborator*, the commonest parasite of the pink boll worm, which has a much longer ovipositor. One egg only is laid in each boll worm. The young larva lives inside the host, feeding at first only on the less vital tissues, such as the fat bodies. So skilfully does it avoid the vital organs that it is not until the Rhogas larva is full grown and has left its host that the latter dies. After leaving the host the larva pupates in a small ovoid silken cocoon, which is generally found beside the remains of the dead boll worm.

Nothing is known of the number of generations of Rhogas that take place in the course of a year, but it is probable that the life-history closely approximates to that of the host, as all the specimens that have been bred

[11] Dudgeon and Gough.—*Bull. Ent. Soc. Egypt*, 1912, pp. 140-141.

appeared at the same time as boll worm moths from the same consignment of bolls. From boll worms from Kharga Oasis perfect insects of Rhogas have emerged in July and in November, and from those from other localities during October, November, and December.

*Rhogas Kitcheneri* has also been bred in the laboratories of the Ministry of Agriculture from the Kharga Oasis date worm, *Ephestia cautella*, Walk. This is, however, the only other known host of Rhogas in Egypt.

*Pediculoides ventricosus*, Newp., a minute mite, ectoparasitic on the pink boll worm, on a variety of other Lepidopterous larvæ, and even on man, has been found by Mr. Willcocks feeding on common boll worms in his laboratory. He has not, however, found it on this host in the field.

In addition to the above there are three Hymenopterous insects which are parasitic on the pink boll worm which may in the future attack the common boll worm also, though they have not been found doing so up to the present. These are *Pimpla roborator*, Fabr. (family Ichneumonidæ), *Limnerium interruptum*, Holmgr. (family Ichneumonidæ), and *Chelonella sulcata*, Nees (family Braconidæ). The first of these, *Pimpla roborator*, is exceedingly abundant on the pink boll worm, and is known to feed on a large variety of boring larvæ. It is highly probable that it may also feed on the common boll worm. The other two species are much less common than the last, though they were far from rare during the autumn of 1913. It is at present early to give any further opinion as to the probabilities, or otherwise, of their parasitizing the common boll worm.

Investigations with regard to the possibilities of multiplying the parasites upon the Earias boll worm are occupying the attention of the Entomological Section of the Ministry of Agriculture, the application of insecticides being impracticable in connection with an interior feeding larva of this description, and reliance having to be almost entirely placed upon the mechanical methods provided for by law. The latter up to the present promise the greatest efficacy.

# APPENDIX I.

## Table showing the Comparison between the Attacks of Earias Boll Worm in the same Localities in 1912 and 1913.

### Observation by Mr. F. C. Willcocks.

| Locality | 1912 | | | | 1913 | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Observation date | Number of bolls examined | Number attacked | Percentage attacked | Observation date | Number of bolls examined | Number attacked | Percentage attacked | Decrease percentage in 1913 |
| Sakha ... ... ... ... | Nov. | 302 | 128 | 42 | Nov. | 250 | 28 | 11 | −31 |
| Mehallet Roh ... ... ... | Sept. | 106 | 25 | 23 | Oct. 7 | 100 | 0 | 0 | −23 |
| | | | | | Oct. 8 | 100 | 5 | 5 | −18 |
| Qesna ... ... ... ... | Sept. | 61 | 27 | 44 | Sept. 11 | 82 | 2 | 2½ | −41½ |
| Batanoun ... ... ... ... | Sept. | 60 | 14 | 23 | Sept. 24 | 200 | 4 | 2 | −21 |
| Zagazig ... ... ... ... | Sept. | 100 | 37 | 37 | Sept. 15 | 100 | 1 | 1 | −36 |
| Mit Gamr ... ... ... ... | Sept. | 97 | 11 | 11⅓ | Sept. 15 | 100 | 3 | 3 | − 8⅓ |
| Simbellawin ... ... ... ... | Sept. | 100 | 23 | 23 | Sept. 20 | 160 | 0 | 0 | −23 |
| Bahtim ... ... ... ... | Sept. | 50 | 10 | 20 | Sept. 8 | 200 | 5 | 2½ | −17½ |
| 37 localities in Lower Egypt ... ... | Sept. | 2,373 | 580 | 22 | — | — | — | — | — |
| 43 localities in Upper Egypt ... ... | — | — | — | — | Sept. A few early Oct. | 5,778 | 178 | 3 | −19 |

# APPENDIX II.

## NOTE ON *RHOGAS KITCHENERI*, DUDGEON AND GOUGH.

By L. H. GOUGH, Ph.D., F.E.S.

*Chief, Entomological Section, Ministry of Agriculture, Egypt.*

The following observations have been made on *Rhogas Kitcheneri*, Dudgeon and Gough.

*Rhogas Kitcheneri* attacks the larvæ of more than one species of moth, the usual Egyptian hosts being *Earias insulana* and *Ephestia cautella*, the common link of which is that the larvæ live inside fruits, such as cotton bolls, dates, etc.

More than one larva develops in each attacked caterpillar, as many as eleven having been noted in one case. The host becomes moribund at least one or two weeks before the Rhogas larvæ leave it to pupate. In the specimens observed the Rhogas larvæ have wandered a few millimetres away from their dead host, and then spun themselves grey, egg-shaped, silken cocoons. The greatest distance wandered before pupation has been 1½ cm.

The Rhogas hatched (in winter in Egypt) about a month to five weeks after pupation, and the insects from one batch hatched on several successive days. The proportion of females to males is occasionally excessive, in one case it was eight females to three males. Copulation took place immediately after expanding and was repeatedly performed.

The adults are rather easily kept alive if fed. Some placed in a Petri dish and fed with wetted lump sugar lived from January 21, 1915, to February 27, 1915, being active at the time of writing. Another lived from January 17, 1915, to February 23, 1915, when it was required as a specimen and killed. Egg-laying has not yet been observed, and in consequence the time required for the larvæ to develop and the age of the victims selected are not known.

Adult *Rhogas Kitcheneri* are frequently found hibernating or hiding inside dried dates, in which they would be able to find moist sugary food.

The attached table shows the dates for two sets:—

| Host observed to be moribund | Larvæ leave their host and spin cocoons | Rhogas hatch | | | Copulation takes place | Duration of life |
|---|---|---|---|---|---|---|
| | | Females | Males | Date | | |
| Dec. 4, 1914 | Dec. 20, 1914 | 4 | 1 | Jan. 20, 1915 | Jan. 20, 1915 | One female died Feb. 13, 1915 |
| | | 3 | 1 | Jan. 21, 1915 | Jan. 21, 1915 | One female died Feb. 15, 1915 |
| | | 1 | 1 | Jan. 23, 1915 | Jan. 23, 1915 | One male died Feb. 13, 1915; remainder alive on Feb. 27, 1915 |
| Jan. 5, 1915 | Jan. 13, 1915 | — | 1 | Feb. 17, 1915 | — | Killed Feb. 23, 1915 |

## Explanation of Plate I.

Figs. 1 to 3.—*Earias insulana,* Boisd. var. *semifascia,* Warren (slightly enlarged).

Figs. 7 and 8.—*Earias insulana*, Boisd. var. *anthophilana,* Snellen (slightly enlarged).

Fig. 14.—*Earias insulana*, Boisd. var. ochreimargo, Warren (slightly enlarged).

Fig. 17.—Pupa of *E. insulana*, Boisd. (slightly enlarged).

Fig. 18.—Cocoon of *E. insulana,* Boisd. (slightly enlarged).

(The other figures represent intermediate forms of *E. insulana*).

Natural sizes are shown by lines below each figure.

## Explanation of Plate II.

Fig. 1.—*Rhogas Kitcheneri,* Dudgeon and Gough, ♂ × 18. A braconid parasitic upon *Earias insulana*. (Natural size 2·25 mm.)

Fig. 2.—Wings of *Rhogas Kitcheneri* × 30, showing the distinctive neuration and darkened areas.

Fig. 3.—Larva of *Earias insulana,* Boisd., × 8, lateral view. (Natural size 11 mm.)

Fig. 4.—Larva of *Earias insulana,* Boisd., × 8, dorsal view. (Natural size 11 mm.)

Natural sizes of figures 1, 3 and 4 are shown by lines below the figures.

# NOTE PRÉLIMINAIRE SUR LES SELS NUISIBLES ET LE COTONNIER EN EGYPTE.

Par VICTOR M. MOSSÉRI.

*Membre de l'Institut Egyptien, Vice-Président de l'Union des Agriculteurs d'Egypte.*

LES terres arables d'Egypte contiennent des sels solubles dont la dose varie depuis des traces jusqu'à 25 pour cent[1] et au delà.

La nature et la proportion de ces sels, de même que leur distribution verticale dans plusieurs terres de ce pays, ont été déjà déterminées.[2]

Parmi ces sels, quelques-uns sont utiles ou inoffensifs, d'autres sont nuisibles à des degrés divers.[3]

L'agriculture égyptienne, a-t-on dit, est une lutte incessante contre les sels. C'est qu'en vérité, ils interviennent si fréquemment et affectent la productivité du sol d'une manière si sensible, qu'il faut toujours en tenir compte parmi les facteurs agrologiques intrinsèques les plus dominants qui règlent cette productivité.

J'ai signalé, il y a quelques années, cette relation étroite qui existe entre les sels et la fertilité des terres

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[1] A moins d'indication contraire, tous les résultats sont exprimés en pour cent de terre sèche.

[2] Lucas, A.—(1°) "Soil and Water of the Fayoum Province," *Survey Department,* 1902; (2°) "Soil and Water of the Wadi Tumilat Lands," *Survey Department,* 1903.

Means.—"Reclamation of Alkali Lands in Egypt," *Bull.* 21, *Bureau of Soils, U.S. Department of Agriculture,* 1903.

Hughes, F.—(1°) "Manurial Trials on Cotton," *Year Book of the Khediv. Agric. Society,* 1909; (2°) "The Occurrence of Sodium Salts in Egypt," *ibid.,* 1905.

Mosséri, V.—(1°) "Nouveau système de drainage et dessalement des terres," *Bull. Institut Egyptien,* tome iii, 1909, et tome v, 1911; (2°) "Les Terrains alcalins en Egypte et leur traitement," *Bull. Institut Egyptien,* tome v, 1911.

[3] Lucas, *loc. cit.;* Mosséri, *loc. cit.*

égyptiennes.[4] Cette relation a été dernièrement confirmée au cours des études entreprises sur une vaste échelle par le Survey Department du Gouvernement Egyptien.[5]

Les résultats de ces travaux seront exposés à ce Congrès par M. Keeling.

L'examen de nombreux échantillons de terres prélevées méthodiquement sur toute la superficie qui forme la région centrale de la province de Gharbia, a décelé environ 0·30 pour cent de sels solubles dans les sols réputés fertiles, 0·50 dans les sols de fertilité moyenne et 0·80 pour cent dans les sols pauvres.

Dans bien des cas, néanmoins, il est indispensable de tenir compte non seulement du résidu total, mais de la nature et de la proportion de chacun des sels en dissolution.[6]

On sait, en effet, que les différents sels ne sont pas toxiques au même degré et que le mélange de deux ou plusieurs sels modifie et, en général, diminue le degré de nocivité de chacun d'eux.

C'est par une telle analyse détaillée qu'il m'a été permis de découvrir la cause de la stérilité, *plus ou moins complète*, de certaines taches que l'on rencontre ça et là dans presque toutes les régions cultivées de l'Egypte, spécialement dans l'Ouest Béhéra, où elles couvrent des milliers d'hectares. Cette improductivité est due à l'existence dans la terre, d'une dose, souvent inférieure à 0·05 pour cent, de carbonate de sodium, le plus nuisible au sol et aux plantes parmi les sels nocifs. La seule détermination en bloc des sels solubles, classerait souvent ces taches stériles dans la catégorie des terres les plus fertiles.[7]

Il est donc toujours intéressant de se renseigner aussi

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[4] Voir Dr. Hume.—" The Study of Soils in Egypt," *Congrès agrogéol. de Stockholm*, 1910, p. 309; et V. Mosséri, " Le drainage en Egypte," *Bull. Institut Egyptien*, tome iii, 1909.

[5] Voir Keeling.—" The Fertility Map of the Delta," *Cairo Scient. Journal*, 1914.

[6] Mosséri, V.—" Nouvelles observations sur le système de lavage superficiel et drainage combinés," *Bull. Institut Egyptien*, tome v, 1911.

[7] Mosséri, V.—*Bull. Institut Egyptien*, tome v, 1911, p. 71.

complètement que possible sur la composition exacte des sels solubles. Tout au plus peut-on, pour les besoins de la pratique courante, et surtout quand il s'agit de terres provenant de régions dont on a déjà étudié les sels en détail, se contenter de déterminer la somme de ces sels[8] et de doser les acides carbonique et bicarbonique des carbonates et bicarbonates alcalins, ainsi que le chlore.

La différence entre le résidu total et la somme des carbonates, bicarbonates et chlorures, exprimés en sels de sodium donne une idée de la quantité des sulfates présents. On complètera ces dosages par la recherche qualitative de la chaux et de la magnésie. D'après cette recherche, on décidera s'il y a lieu ou non de doser ces éléments en même temps que l'acide sulfurique.

L'étude du degré de tolérance du cotonnier à l'égard des différents sels que l'on rencontre dans les terres égyptiennes est, comme bien l'on pense, un problème fort complexe. Plusieurs facteurs étrangers interviennent souvent pour gêner plus ou moins le développement des plantes en observation, tels que: conditions climatériques défavorables, attaques de parasites végétaux ou animaux, conditions physiques ou d'aération imparfaite du sol et du sous-sol, nappe souterraine élevée, mauvaise irrigation, drainage défectueux, etc.

D'autre part, le degré de tolérance varie, en dehors des causes extérieures que l'on vient de rappeler, suivant des conditions qui tiennent aux caractères individuels,[9] à la nature des terres, au mode de culture adopté, à la composition des solutions salines, etc. L'humidité du sol, notamment par la dilution qu'elle produit, joue un rôle considérable. Cette humidité est à son tour, sous la dépendance de la fréquence et de l'abondance des arro-

[8] De préférence par résistivité au moyen du pont électrolytique de Whitney, d'après des courbes établies au préalable pour les diverses régions à examiner et en prenant les précautions nécessaires dans le cas des terres alcalines ou riches en matières organiques.

[9] Kearney et Harter.—"Comparative Tolerance of various Plants for the Salts common in Alkali Soils," *Bull.* 113, *Bureau of Plant Industry, U.S. Department of Agriculture*, 1907.

sages, de la texture de la terre ainsi que des conditions du drainage et des eaux souterraines. Le niveau de ces eaux détermine dans la terre la distribution verticale des sels, distribution qu'il y a lieu de considérer dans ses relations avec le caractère du système radiculaire de la plante.

Mon but aujourd'hui est plutôt de fixer les limites de salure compatibles avec des rendements élevés de coton de qualité supérieure et, comme conséquence, de rechercher jusqu'à quel point il convient de pousser les opérations de dessalement des terres pour les rendre aptes à produire de telles récoltes.

Tout en me bornant dans cette note à l'étude de la Basse-Egypte, la seule région du reste qui produise les diverses variétés estimées de coton égyptien, j'emprunterai certains de mes exemples à quelques terres de la Haute-Egypte.

Pour la commodité de mon exposé, j'envisagerai d'abord le Sud et le Centre de la Basse-Egypte, pour parler ensuite de la partie septentrionale qui offre quelques particularités dignes de remarque.

Plusieurs déterminations faites sur des terres à coton de diverses localités m'ont montré que dans le Sud et le Centre de cette région il est rare que les terres qui produisent des rendements élevés de 5 kantars et au delà par feddan contiennent, *dans la tranche utile exploitée par les racines*, plus de 0·25 à 0·30 pour cent de sels solubles.

Voici pour servir de types, la composition et le pourcentage de ces sels trouvés dans deux terres fertiles choisies au hasard parmi celles que j'ai étudiées, et situées l'une à Bata, Menoufia (Sud), l'autre à Kafr-Soliman, Gharbia (Centre). (Voir Tableau I.)

Il ne faut pas oublier que dans ces analyses comme dans toutes celles qui vont suivre, les ions trouvés ont été combinés entre eux d'une manière conventionnelle qui sera indiquée plus loin. Bien que les lois physico-chimiques des solutions d'électrolytes justifient quelque peu les groupements adoptés, il est évident que les ions dosés dans les solutions aqueuses des terres peuvent et

## TABLEAU I.

### Sels solubles de quelque terres fertiles.

| Elements solubles pour cent térre sèche | Sud du Delta (1) Bata (Menoufia) | | | | Centre du Delta Kafr-Soliman (Gharbia) | | |
|---|---|---|---|---|---|---|---|
| | Hod el Hicha 1910 | | Sibii Bahari 1910 | | Hod Galantai 1913 | | |
| | Sol | Sous sol | Sol | Sous sol | 0 à 30 cm. | 30 à 60 cm. | 60 à 90 cm. |
| *Ions :* | | | | | | | |
| Acide sulfurique ($SO_4$) ... | 0·016 | traces | 0·016 | 0·016 | traces | traces | traces |
| Chlore (Cl) .. ... | 0·026 | 0·017 | 0·019 | 0·022 | 0·017 | 0·016 | 0·019 |
| Acide nitrique ($NO_3$) ... | non dosé | non dosé | non dosé | non dosé | 0·003 | 0·005 | 0·002 |
| Acide carbonique ($CO_3$) ... | — | — | — | — | 0·000 | 0·000 | 0·000 |
| Acide bicarbonique ($HCO_3$) | 0·154 | 0·124 | 0·114 | 0·078 | 0·085 | 0·079 | 0·097 |
| Calcium (Ca) ... ... | 0·032 | 0·024 | 0·017 | 0·014 | 0·016 | 0·016 | 0·011 |
| Magnésium (Mg) ... | 0·005 | 0·005 | 0·005 | 0·006 | 0·008 | 0·006 | 0·005 |
| Potassium (K) ... ... | 0·009 | 0·005 | 0·007 | 0·010 | non dosé | non dosé | non dosé |
| Sodium (Na) ... ... | 0·032 | 0·019 | 0·030 | 0·019 | 0·011 | 0·013 | 0·030 |
| *Combinaisons conventionnelles :* | | | | | | | |
| Sulfate de calcium ... | 0·023 | traces | 0·023 | 0·023 | traces | traces | traces |
| ,, magnésium ... | — | — | — | — | — | — | — |
| Chlorure de calcium ... | 0·041 | 0·027 | 0·029 | 0·019 | 0·027 | 0·025 | 0·030 |
| ,, magnésium ... | — | — | — | — | — | — | — |
| ,, sodium ... | — | — | — | 0·016 | — | — | — |
| Nitrate de calcium ... | non dosé | non dosé | non dosé | non dosé | 0·004 | 0·007 | — |
| ,, sodium ... | non dosé | non dosé | non dosé | non dosé | — | — | 0·005 |
| Bicarbonate de calcium ... | 0·040 | 0·056 | — | — | 0·020 | 0·020 | — |
| ,, magnésium | 0·030 | 0·030 | 0·030 | 0·036 | 0·049 | 0·036 | 0·030 |
| ,, potassium | 0·023 | 0·012 | 0·017 | 0·024 | non dosé | non dosé | non dosé |
| ,, sodium ... | 0·117 | 0·069 | 0·109 | 0·047 | 0·040 | 0·047 | 0·099 |
| Total soluble ... | 0·274 | 0·194 | 0·208 | 0·165 | 0·140 | 0·135 | 0·164 |
| *Pour cent du residu sec :* | | | | | | | |
| Sulfate de calcium ... | 8·4 | traces | 11·0 | 13·9 | traces | traces | traces |
| Chlorure de calcium ... | 14·9 | 13·9 | 13·9 | 11·5 | 19·3 | 18·5 | 18·3 |
| ,, sodium ... | — | — | — | 9·6 | — | — | — |
| Nitrate de calcium ... | — | — | — | — | 2·9 | 5·2 | — |
| ,, sodium ... | — | — | — | — | — | — | 3·0 |
| Bicarbonate de calcium ... | 14·9 | 28·7 | — | — | 14·3 | 14·8 | — |
| ,, magnésium | 10·9 | 15·4 | 14·4 | 21·8 | 35·0 | 26·7 | 18·3 |
| ,, potassium | 8·4 | 6·2 | 8·1 | 14·5 | non dosé | non dosé | non dosé |
| ,, sodium ... | 42·5 | 35·8 | 52·6 | 28·7 | 28·5 | 34·8 | 60·4 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

(1) Dans une terre de Bata on a dosé, par les méthodes ordinaires, directement, les eléménts suivants :

| | | |
|---|---|---|
| Bicarbonate de calcium ... ... | 0·036 | pour cent de terre séche |
| ,, ,, magnésium ... ... | 0·031 | ,, ,, |
| Sulfate de calcium ... ... ... | 0·048 | ,, ,, |
| Potasse ($K_2O$) ... ... ... | 0·004 | ,, ,, |
| Soude ($Na_2O$) ... ... ... | 0·008 | ,, ,, |
| Silice ($SiO_2$) ... ... ... | 0·012 | ,, ,, |
| Acide nitrique ($NO_3$) ... ... | 0·010 | ,, ,, |
| Chlore ... ... ... ... | 0·022 | ,, ,, |
| Acide phosphorique ... ... ... | 0·0008 | ,, ,, |

doivent s'y trouver sous toutes les combinaisons possibles et même en dissociation.

Quoi qu'il en soit, ces dosages montrent que les sels solubles des bonnes terres du Sud et du Centre consistent principalement en bicarbonates de calcium, de magnésium, de potassium et de sodium. Ce dernier sel à lui seul forme jusqu'à la moitié et au-delà. La somme des bicarbonates peut atteindre les 75 ou 80 pour cent et plus du total soluble.

Les sulfates sont présents en faibles quantités ou même absents; souvent à l'état de sulfate de calcium utile.

La proportion des chlorures varient entre 15 et 20 ou 25 pour cent de l'ensemble des sels. C'est surtout le chlorure de calcium qui prédomine. Les carbonates alcalins, notamment le carbonate de sodium, font défaut. Parfois il y a une réaction à peine sensible à la phénolphtaleine. Cette réaction peut être due aux silicates. On sait que les silicates et bisilicates alcalins se comportent comme les carbonates et bicarbonates alcalins. Je ne saurais m'étendre davantage sur cette composition des solutions salines sans sortir du cadre de cette note. Ce que j'en ai dit suffit pour les besoins de mon sujet.

Parmi les sels présents que je viens de mentionner, les chlorures doivent retenir plus particulièrement notre attention, et, en l'absence du carbonate de sodium, ce sont les seuls éléments importants, ainsi que je l'ai indiqué ailleurs.[10] Or, dans les terres fertiles du sud et du centre, sur les 0·25 à 0·30 pour cent de sels que l'on trouve dans la couche où se nourrissent les racines, il n'y a guère plus de 0·1 pour cent de chlorures exprimés en chlorure de sodium.

Quand on passe aux terres moins fertiles, parce que plus salées, ce sont les chlorures et les sulfates surtout qui augmentent. On rencontre ces derniers plus spécialement et en quantité assez grande dans les terres infiltrées, comme il sera dit plus loin.

Des variations de moins de 0·1 pour cent dans la dose

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[10] *Loc. cit.*, p. 55.

des chlorures font sentir leur effet sur le rendement et l'on peut déduire de mes observations qu'à 0·2 pour cent de chlorure de sodium les rendements, *toutes choses égales d'ailleurs,* tombent de 5 ou 6 à 3 ou 4 kantars par feddan. A 0·4 pour cent ils ne sont plus que de 1 à 2 kantars. Quand la terre renferme 0·5 pour cent et au delà du dit sel, elle ne produit plus de coton.

Il ne faudrait pas attacher, bien entendu, une valeur absolue à ces chiffres : les chlorures ne forment presque jamais à eux seuls la masse des sels nuisibles.

D'autre part, le rendement n'est pas sous la seule dépendance des sels. Divers facteurs interviennent. J'ai vu des terres qui produisent normalement 6 kantars, donner en 1909 ½ kantar seulement par suite des ravages du *Prodenia litura.* En ce qui concerne les facteurs agrologiques mêmes, on peut dire qu'en dehors du mode d'exploitation et d'aménagement du sol, et quelquefois de la dose d'azote disponible, la production cotonnière est réglée par les propriétés physiques de la terre, sa teneur en sels, ses conditions d'irrigation et de drainage, et, enfin, par le régime des eaux souterraines.

Le cotonnier paraît beaucoup plus résistant aux sulfates qu'aux chlorures. Cependant il est difficile de donner des chiffres pour le Centre et le Sud du Delta, parce que, dans ces régions, il est rare que l'action des sulfates ne soit pas entièrement dominée et masquée par celle des chlorures. Les sulfates prédominent, par exemple, quand les sels proviennent de l'évaporation des eaux d'infiltration de canaux en charge : —

TABLEAU II.

SELS DES TERRES INFILTRÉES.

*Centre du Delta. Kafr-Soliman (Gharbia).*

| | |
|---|---|
| Résidu sec ... ... ... ... ... | 2·320 |
| Bicarbonate de sodium ... ... ... | 0·170 |
| Chlorure de sodium ... ... ... ... | 0·136 |
| Sulfate de sodium ... ... ... ... | 1·570 |

Mais dans ce cas la plante dépérit plutôt par asphyxie et il est difficile sinon impossible de distinguer l'action des sulfates. Ceux-ci se présentent quelquefois, en partie du moins, à l'état de sulfate de calcium, utile par lui-même, et diminuant de beaucoup le degré de toxicité des autres sels qui l'accompagnent.

D'autres fois on rencontre du sulfate de magnésium assez nuisible.

La limite de tolérance du cotonnier à l'égard du sulfate de sodium a été trouvée voisine de 0·25 pour cent dans le Wadi Tumilat.[11] Cette limite doit être sans doute plus élevée encore, tout au moins en présence du sulfate de calcium, si l'on en juge par les recherches que j'ai faites dans le Nord du Delta. (Voir Tableau XI.) La question mérite d'être étudiée, en raison du fait que les sels qui s'accumulent dans la couche supérieure des terres soumises à l'action des canaux en charge, se composent la plupart du temps en grande partie de sulfate de sodium, comme le prouvent les analyses suivantes. (Voir Tableau III.)

TABLEAU III.

EFFLORESCENCES SALINES.

| Recueillies à la surface des terres infiltrées à Kafr-Soliman (Centre du Delta) | | Recueillies sur talus drains à Ebchan (Nord du Delta) | |
|---|---|---|---|
| *Résidu sec total* ... ... | 88·579 | *Résidu sec total* ... ... | 71·271 |
| *Sels p. cent du résidu sec :* | | *Sels p. cent du résidu sec :* | |
| Sulfate de calcium ... | 0·860 | Sulfate de calcium ... | 1·520 |
| ,, magnésium... | 0·850 | ,, magnésium | 4·390 |
| ,, potassium ... | 0·500 | ,, potassium | non dosé |
| ,, sodium ... | 95·590 | ,, sodium ... | 89·420 |
| Chlorure de magnésium | — | Chlorure de magnésium | 4·200 |
| ,, sodium ... | 1·970 | ,, sodium ... | 0·000 |
| Nitrate ,, ... | non dosé | Nitrate ,, ... | 0·000 |
| Carbonate ,, ... | traces | Carbonate ,, ... | traces |
| Bicarbonate ,, ... | 0·230 | Bicarbonate ,, ... | 0·470 |
| | 100·000 | | 100·000 |

Il est vrai que dans ce cas le seul remède efficace est de soustraire les terres aux infiltrations par les moyens déjà longuement discutés ailleurs.[12]

Le cotonnier tolère la présence dans le sol d'une

[11] Lucas.—(2°) *Loc. cit.*

[12] Willcocks, Sir W.—" Egyptian Irrigation," 3rd edition.
Audebeau Bey.—" Rapports présentés à la Commission des Domaines de l'Etat Egyptien," 1909-1912.
Mosséri, V.—" Le Drainage en Egypte," *Bull. Institut Egyptien,* tome iii, 1909.

quantité assez élevée de bicarbonates. Effectivenent, ceux-ci forment la plus grande partie des sels solubles que l'on rencontre dans les terres les plus fertiles, ainsi que je l'ai indiqué ci-dessus.

Néanmoins lorsque la dose de bicarbonate de sodium atteint environ 0·2 pour cent, il y a lieu de le considérer comme virtuellement dangereux, parce qu'il est susceptible dans certaines conditions de se transformer, en partie du moins, en carbonate très nuisible au sol et à la plante.

Le cotonnier est en réalité très *sensible* aux effets de ce dernier sel. Une dose de 0·1 pour cent suffit à rendre une terre argileuse comme le sont plus ou moins les alluvions nilotiques, impropre à la culture de cette plante. Une telle terre devient compacte et donne de faibles rendements dès qu'elle renferme 0·035 à 0·040 pour cent de carbonate de sodium, ou alcali noir, avec 0·20 à 0·25 de bicarbonate. Tel est, par exemple, le cas d'une terre de Cheblanga (Kafr-Atalla) située au milieu d'une région très fertile de la Galioubia. (Voir Tableau IV.)

## TABLEAU IV.

### Terres alcalines du Sud du Delta.

*Cheblanga* (*Galioubia*).

| Eléments solubles pour cent terre sèche | Sol 0 à 30 cm. |
|---|---|
| *Ions :* | |
| Acide sulfurique ($SO_4$) ... ... ... | traces |
| Chlore (Cl) ... ... ... ... | 0·014 |
| Acide carbonique ($CO_3$) ... ... ... | 0·026 |
| A. bicarbonique ($HCO_2$) ... ... ... | 0·180 |
| Calcium (Ca) ... ... ... ... | 0·008 |
| Magnésium (Mg) ... ... ... ... | traces |
| Potassium (K) ... ... ... ... | 0·006 |
| Sodium (Na) ... ... ... ... | 0·084 |
| *Combinaisons conventionnelles :* | |
| Sulfate de calcium ... ... ... | traces |
| ,, magnésium ... ... ... | traces |
| Chlorure de calcium ... ... ... | 0·022 |
| ,, sodium ... ... ... | — |
| Carbonate de potassium ... ... ... | 0·010 |
| ,, sodium ... ... ... | 0·038 |
| Bicarbonate ,, ... ... ... | 0·248 |
| Total soluble ... ... ... | 0·318 |
| *Pour cent du résidu sec :* | |
| Chlorure de calcium ... ... ... | 6·9 |
| Bicarbonate de potassium ... ... ... | 3·1 |
| ,, sodium ... ... ... | 12·0 |
| Carbonate de ,, ... ... ... | 78·0 |
| | 100·0 |

Le plâtrage dans ce cas est éminemment utile. Les propriétaires de cette terre se plaignaient avant l'application du plâtre, de la très grande compacité du sol et de sa faible productivité. Pour y cultiver du coton, on était obligé de recourir à de nombreux artifices d'arrosages et de façons culturales. Malgré cela on y obtenait difficilement 3 ou 4 kantars par feddan. Le plâtre, en ameublissant cette terre, a porté son rendement à 6 kantars. Ceci démontre que le cotonnier est très sensible aux conditions d'aération et d'ameublissement du sol.[13] Le carbonate alcalin aux faibles doses précitées est surtout nuisible par son action sur la terre qu'il rend plus ou moins compacte et imperméable.

Un bel exemple de l'influence du carbonate de sodium sur la végétation nous est offert par les analyses suivantes relatives à trois terres de la plaine de Kom-Ombo formant partie d'une même parcelle, ayant au point de vue physique la même constitution et où l'analyse chimique décèle à peu près les mêmes quantités d'éléments fertilisants. (Voir Tableau V.)

TABLEAU V.

EFFETS DU CARBONATE DE SODIUM SUR LES RENDEMENTS COTONNIERS.

*Terres alcalines de la Plaine de Kom-Ombo.*

| Eléments solubles pour cent terre sèche | Terre donnant de 0 à 1 kantar de coton au feddan No. 1 | Terre donnant 3 kantars de coton au feddan No. 2 | Terre donnant 5 kantars de coton au feddan No. 3 |
|---|---|---|---|
| Chlorure de sodium ... | 0·275 | 0·200 | 0·125 |
| Carbonate ,, ... | 0·085 | 0·045 | traces |
| Bicarbonate ,, ... | 0·246 | 0·117 | 0·152 |
| Acide sulfurique... ... | traces indosables | traces indosables | traces indosables |
| Calcium ... ... | ,, ,, | ,, ,, | ,, ,, |
| Magnésium ... ... | ,, ,, | ,, ,, | ,, ,, |

La terre No. 1, qui ne donne que de 0 à 1 kantar de coton au feddan, contient, comme on le voit, 0·085 pour cent de carbonate et 0·246 pour cent de bicarbonate de

[13] Ceci confirme les résultats obtenus par Kearney en Amérique : "Egyptian Cotton as affected by Soil Variations," *Circular* 112, *Bureau of Plant Industry*, *U.S. Department of Agriculture*, 1913.

sodium, soit environ deux fois plus de carbonate que la terre No. 2 produisant 3 kantars. La terre No. 3, d'un rendement de 5 kantars au feddan, ne contient que des traces de carbonate et 0·152 pour cent de bicarbonate.

Le dose de carbonate et bicarbonate dans ces terres de nature argileuse, quoique à un moindre degré que la terre de Cheblanga, explique les écarts observés dans leurs rendements. Il n'y a presque pas, en effet, de sulfates nuisibles et les teneurs en chlorures ne justifient point ces différences.

Je citerai encore, comme autre exemple, deux terres de la région de Nag Hamadi, Haute-Egypte, situées côte à côte, l'une très fertile, l'autre difficile à travailler et de faible rendement.

L'analyse physique et le dosage des matières fertilisantes ne montrent presque pas de différences sensibles entre les deux terres, sauf que la mauvaise terre est plus argileuse (80 pour cent d'argile).

A l'examen des sels solubles on a trouvé de 0·011 à 0·031 pour cent de carbonate de sodium et de 0·098 à 0·131 pour cent de bicarbonate dans la mauvaise terre, alors que dans la bonne terre il n'y avait que des traces de carbonates et 0·092 pour cent de bicarbonate de sodium. Dans les deux cas le total soluble ne s'élevait guère au delà de 0·14 à 0·2 pour cent. Le plâtrage a très heureusement modifié la mauvaise terre.[14]

Le cas de ces dernières terres nous montre, une fois de plus, combien il est parfois utile de ne pas se borner à la seule détermination en bloc des sels solubles.

On peut déduire de l'ensemble des exemples cités que le carbonate de sodium est d'autant plus nuisible aux rendements du cotonnier que la terre est plus argileuse; qu'il suffit quelquefois d'une quantité inférieure à 0·025 pour cent de ce sel pour affecter défavorablement les dits rendements; qu'en tout cas une dose d'environ 0·05 pour cent paraît néfaste, à moins qu'il s'agisse de terres plus ou moins sablonneuses; qu'enfin il est toujours utile de se renseigner sur la teneur du sol en bicarbonate et de

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[14] Voir Mosséri, V.—*Bull. Institut Egyptien,* tome v, 1911, p. 71.

prendre les mesures nécessaires pour en empêcher la transformation en carbonate. Ces différentes conclusions tirées de l'étude de la Haute-Egypte et du Sud du Delta se confirment par les analyses suivantes relatives à une terre de Talbant-Kaissar (Gharbia) faisant partie du centre cotonnier le plus fertile et le plus réputé de la Basse-Egypte. Cette terre donne à peine 3 kantars au feddan, alors que le rendement des terres avoisinantes dépasse 5 et 6 kantars. (Voir Tableau VI.)

TABLEAU VI.

TERRES ALCALINES DU CENTRE DU DELTA.

*Talbant-Kaissar (Gharbia).*

| Eléments solubles pour cent terre sèche | Hod Talbant 30 cm. | 30 à 60 cm. |
|---|---|---|
| *Ions :* | | |
| Acide sulfurique ($SO_4$) ... ... | 0·033 | traces |
| Chlore (Cl) ... ... ... | 0·029 | 0·031 |
| Acide nitrique ($NO_3$) ... ... | 0·005 | 0·002 |
| ,, carbonique ($CO_3$) ... ... | 0·024 | 0·030 |
| ,, bicarbonique ($HCO_3$) ... | 0·146 | 0·158 |
| Calcium (Ca) ... ... ... | 0·007 | 0·007 |
| Magnésium (Mg) ... ... | 0·011 | 0·003 |
| Sodium (Na) ... ... ... | 0·080 | 0·089 |
| *Combinaisons conventionnelles ;* | | |
| Sulfate de calcium ... ... | 0·024 | traces |
| ,, magnésium ... ... | 0·020 | — |
| Chlorure de calcium ... ... | — | 0·019 |
| ,, magnésium ... ... | 0·028 | 0·012 |
| ,, sodium ... ... | 0·013 | 0·016 |
| Nitrate de sodium ... ... | 0·007 | 0·003 |
| Carbonate ,, ... ... | 0·042 | 0·053 |
| Bicarbonate ,, ... ... | 0·201 | 0·217 |
| Total soluble ... ... | 0·335 | 0·320 |
| *Pour cent du résidu sec :* | | |
| Sulfate de calcium ... ... | 7·2 | traces |
| ,, magnésium ... ... | 5·9 | — |
| Chlorure de calcium ... ... | — | 5·9 |
| ,, magnésium ... ... | 8·3 | 3·8 |
| ,, sodium ... ... | 3·9 | 5·0 |
| Nitrate de sodium ... ... | 2·1 | 1·0 |
| Carbonate ,, ... ... | 12·7 | 16·6 |
| Bicarbonate ,, ... ... | 59·9 | 67·7 |
| | 100·0 | 100·0 |

Voilà ce que j'ai cru intéressant de noter en ce qui concerne l'action des sels nuisibles sur le cotonnier dans le Centre et le Sud de la Basse-Egypte.

De ce que le *cotonnier végète* dans le Nord du Delta sur des terres dont le sous-sol contient des quantités élevées de sels nuisibles, on en conclut d'ordinaire que cette plante manifeste à leur égard une grande résistance. D'aucuns admettent que dans le Nord du Delta une dose de 1 à 1·5 pour cent[15] de chlorure de sodium dans le sol est non seulement inoffensive, mais plutôt favorable à la végétation et au rendement de cette malvacée. D'après eux, le sel, en empêchant les tiges et les feuilles de prendre un trop grand développement hâterait la maturité; ce qui est très important dans ces parties septentrionales où les conditions climatériques obligent à semer plus tard et à récolter plus tôt que dans le Centre et le Sud du Delta. De plus, le sel améliorerait la longueur, la résistance et la couleur des fibres.

Cependant, déjà en 1902, Means et Kearney[16] n'avaient trouvé dans les 60 premiers centimètres de profondeur de quelques champs de cotonniers d'Aboukir près d'Alexandrie que 0·60 pour cent de sels solubles dans les parties où les plantes étaient parfaitement saines, 1·8 pour cent dans celles où l'on rencontrait de distance en distance quelques pieds plus ou moins résistants, et enfin 2 pour cent et au delà dans les endroits où les plantes n'avaient pu végéter.

Etant donnée l'importance qui s'attache à la question, surtout dans la mise en valeur des "Bararis" ou terres salées incultes du Nord du Delta, j'ai résolu d'entreprendre une série de recherches en vue de déterminer dans la région septentrionale de la Basse-Egypte l'action des sels nuisibles sur la végétation et le rendement du cotonnier.

A cet effet j'ai choisi, en 1907, à Manchieh Kafr el Garaida, près Belcas (Gharbia), cinq champs, dont trois étaient cultivés en Mitafifi; les deux autres en Jannovitch et Abassi. Ces champs sont désignés ci-après par les lettres C, D, E; A et B respectivement.

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15 *Bull.* 42, *Office of Experiment Stations, U.S. Department of Agriculture*, 1897, p. 11.

16 "Crops used in the Reclamation of Alkali Lands in Egypt," *Year-book of the U.S. Department of Agriculture*, 1902, p. 586.

Dans chaque champ on a choisi des parcelles correspondant aux quatre types de végétation suivants : —

(*a*) Plants non développés.
(*b*) Plants peu développés.
(*c*) Plants moyennement développés.
(*d*) Plants bien développés.

Ces quatre types sont réprésentés sur les tableaux (VII à X) par les lettres *a*, *b*, *c*, *d*, respectivement.

Sur chaque parcelle on a prélevé 4 échantillons représentant : le premier, la terre de la crète des " mastabas " ou billons, sur une épaisseur de 2 ou 3 centimètres seulement; le second, la terre de la couche exploitée par les racines, couche dont l'épaisseur, mesurée d'après la longueur du pivot des plantes, varie de 10 à 40 centimètres, suivant les types de végétation précités, la troisième, la terre située au-dessous des pivots sur une épaisseur de 30 centimètres; le quatrième enfin, la terre de la tranche des 30 centimètres sous-jacents.

A cette profondeur on a presque toujours rencontré les eaux souterraines dont on a également prélevé des échantillons. Ces eaux ont été trouvées salées. Elles contenaient suivant les parcelles de 2 à 12 pour cent de sels dont 0·5 à 10 pour cent environ de chlorures. Tous les échantillons ont été pris en août, entre deux arrosages,

| | Type non développé | Type peu développé | Type moyennement développé | Type bien développé |
|---|---|---|---|---|
| Longueur du pivot | om. 07 à om. 10 | om. 15 à om. 19 | om. 20 à om. 30 | om. 30 à om. 40 |
| Hauteur des tiges | om. 15 à om. 18 | om. 34 à om. 37 | om. 54 à om. 65 | om. 75 à 1m. 25 |
| Profondeur à laquelle on rencontre les eaux souterraines | om. 57 à om. 60 | om. 57 à om. 62 | om. 60 à om. 65 | om. 60 à om. 70 |
| Rendements approxim. au feddan en kantars | 0 | 0 à 1 | 1 à 2 | 3 à 5 |

ce qui est avantageux pour le but à atteindre. Le tableau ci-dessus donne en moyenne les renseignements relatifs aux quatre types de végétation choisis.

Le rendement des types bien développés correspond à environ : —

3 kantars au feddan pour les parcelles A, B, C.
4 ,, ,, la parcelle D.
5 ,, ,, ,, E.

Les tableaux VII à X résument les détails des différentes déterminations qui ont été faites. Sauf pour les terres cultivées en Abassi et Jannovitch qui ont été analysées sommairement et dont les analyses ne sont pas données ici, pour les autres on a déterminé pour chacune, directement, tous les éléments portés aux tableaux, à l'exception du sodium qui a été calculé par différence. Pour cela les ions basiques Ca et Mg ont été combinés aux ions acides dans l'ordre suivant : $SO_4$, Cl, $CO_3$, $HCO_3$, $NO_3$. L'excès des ions acides a été combiné ensuite au sodium. On a préféré pour des raisons déjà données ailleurs,[17] recourir à cette détermination indirecte et laisser de côté le dosage du potassium.[18]

Je ne discuterai que les résultats des parcelles, C, D, E, dont les terres ont été ainsi analysées. Les analyses sommaires des deux parcelles A et B corroborent, du reste, ces résultats.

Ces divers dosages mettent en évidence plusieurs points intéressants. Je me bornerai ici à signaler les principaux.

Dans les régions septentrionales du Delta comme

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[17] Voir Mosséri, V.—" Nouveau système de drainage et de dessalement des terres," Montpellier, 1912, p. 18.

[18] Les différences que l'on constate dans toutes les analyses entre la somme des sels obtenue d'après les groupements conventionnels et celle que donne le résidu sec, provient de la transformation des bicarbonates en carbonates pendant l'évaporation et la dessication. D'autre part, le résidu sec comprend de la silice, des traces de fer et d'alumine des matières organiques, etc.

| Parcelles | Types de végétation | Sulfates | | | Chlorures | | | Nitrate de sodium $NaNO_3$ | Bicarbonate de sodium $NaHCO_3$ | Total soluble pour cent terre sèch[e] |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $CaSO_4$ | $MgSO_4$ | $Na_2SO_4$ | $CaCl_2$ | $MgCl_2$ | NaCl | | | |
| | | | | *Crête des billons* | | | | | | |
| C | *a* | 0·306 | 0·190 | 0·091 | — | — | 0·850 | 0·030 | 0·143 | 1·610 |
| D | *a* | 1·734 | 0·270 | — | — | 1·211 | 2·892 | 0·135 | 0·051 | 6·293 |
| E | *a* | 0·886 | — | — | 0·888 | 1·710 | 4·967 | 0·001 | 0·096 | 8·548 |
| Moyennes : | | 0·975 | 0·230 | 0·091 | 0·888 | 1·460 | 2·903 | 0·055 | 0·096 | 5·483 |
| C | *b* | 0·163 | 0·143 | — | — | 0·059 | 1·163 | 0·066 | 0·174 | 1·768 |
| D | *b* | 0·238 | 0·040 | — | — | 0·095 | 0·608 | traces | 0·085 | 1·066 |
| E | *b* | 0·693 | — | — | 0·546 | 0·938 | 2·569 | 0·0015 | 0·079 | 4·826 |
| Moyennes : | | 0·364 | 0·091 | — | 0·546 | 0·364 | 1·446 | 0·033 | 0·112 | 2·553 |
| C | *c* | 0·136 | 0·110 | 0·290 | — | — | 0·780 | 0·030 | 0·143 | 1·489 |
| D | *c* | 0·108 | 0·105 | 0·029 | — | — | 0·500 | traces | 0·096 | 0·838 |
| E | *c* | 0·136 | 0·105 | 0·038 | — | — | 0·146 | — | 0·143 | 0·568 |
| Moyennes : | | 0·126 | 0·106 | 0·119 | — | — | 0·475 | 0·030 | 0·127 | 0·965 |
| C | *d* | 0·646 | 0·475 | 0·139 | — | — | 0·770 | 0·067 | 0·095 | 2·192 |
| D | *d* | indosé | 0·170 | indosé | indosé | indosé | 0·880 | indosé | 0·096 | 1·400 |
| E | *d* | 0·190 | 0·100 | — | — | 0·091 | 0·793 | 0·009 | 0·096 | 1·279 |
| Moyennes : | | 0·418 | 0·248 | 0·139 | — | 0·091 | 0·814 | 0·038 | 0·095 | 1·623 |
| | | | | *Zone des racines* | | | | | | |
| C | *a* | 0·054 | 0·065 | 0·057 | — | — | 0·361 | traces | 0·206 | 0·743 |
| D | *a* | 0·127 | — | — | 0·091 | 0·110 | 0·675 | 0·008 | 0·085 | 1·096 |
| E | *a* | 0·221 | — | — | 0·086 | 0·277 | 1·248 | — | 0·079 | 1·911 |
| Moyennes : | | 0·134 | 0·065 | 0·057 | 0·088 | 0·193 | 0·761 | 0·008 | 0·123 | 1·250 |
| C | *b* | 0·081 | 0·004 | — | — | 0·047 | 0·255 | traces | 0·239 | 0·626 |
| D | *b* | 0·272 | 0·160 | 0·103 | — | — | 0·450 | traces | 0·067 | 1·052 |
| E | *b* | 0·163 | 0·215 | 0·087 | — | — | 1·170 | — | 0·111 | 1·746 |
| Moyennes : | | 0·172 | 0·126 | 0·095 | — | 0·047 | 0·625 | — | 0·139 | 1·141 |
| C | *c* | traces | traces | 0·109 | — | — | 0·130 | — | 0·159 | 0·390 |
| D | *c* | 0·068 | 0·130 | 0·189 | — | — | 0·420 | traces | 0·111 | 0·918 |
| E | *c* | 0·081 | 0·051 | — | — | 0·028 | 0·294 | — | 0·143 | 0·599 |
| Moyennes : | | 0·074 | 0·090 | 0·149 | — | 0·028 | 0·281 | — | 0·137 | 0·635 |
| C | *d* | 0·190 | 0·130 | 0·032 | — | — | 0·110 | traces | 0·095 | 0·557 |
| D | *d* | 0·163 | 0·065 | 0·049 | — | — | 0·093 | traces | 0·111 | 0·481 |
| E | *d* | 0·034 | — | — | 0·060 | 0·067 | — | — | 0·111 | 0·272 |
| Moyennes : | | 0·129 | 0·097 | 0·040 | 0·060 | 0·067 | 0·101 | — | 0·105 | 0·436 |

## ES PARCELLES C, D, E.

| Parcelles | Types de végétation | Sulfates | | | Chlorures | | | Nitrate de sodium $NaNO_3$ | Bicarbonate de sodium $NaHCO_3$ | Total soluble pour cent terre sèche |
|---|---|---|---|---|---|---|---|---|---|---|
| | | $CaSO_4$ | $MgSO_4$ | $Na_2SO_4$ | $CaCl_2$ | $MgCl_2$ | NaCl | | | |
| 0 *mètre à* 30 *centimètres au-dessous du pivot.* | | | | | | | | | | |
| C | *a* | 0·108 | 0·065 | 1·541 | — | — | 0·530 | traces | 0·159 | 2·40 |
| D | *a* | 0·578 | 0·365 | 0·358 | — | — | 1·120 | — | 0·067 | 2·48 |
| E | *a* | 0·272 | 0·316 | — | — | 0·107 | 1·120 | — | 0·079 | 1·89 |
| Moyennes : | | 0·319 | 0·248 | 0·949 | — | 0·107 | 0·923 | — | 0·101 | 2·25 |
| C | *b* | 0·272 | 0·345 | 0·683 | — | — | 1·030 | traces | 0·159 | 2·49 |
| D | *b* | 0·170 | 0·160 | 0·060 | — | — | 1·200 | traces | 0·085 | 1·67 |
| E | *b* | 0·299 | 0·365 | 0·350 | — | — | 0·890 | — | 0·143 | 2·047 |
| Moyennes : | | 0·247 | 0·290 | 0·364 | — | — | 1·040 | — | 0·129 | 2·069 |
| C | *c* | 0·190 | 0·170 | 0·739 | — | — | 0·130 | traces | 0·111 | 1·340 |
| D | *c* | 0·163 | 0·120 | 0·483 | — | — | 0·390 | — | 0·111 | 1·357 |
| E | *c* | 0·128 | — | — | 0·03 | 0·103 | 0·171 | 0·000 | 0·111 | 0·543 |
| Moyennes : | | 0·160 | 0·190 | 0·611 | 0·03 | 0·103 | 0·230 | 0·000 | 0·111 | 1·080 |
| C | *d* | 0·340 | 0·215 | 0·647 | — | — | 0·290 | traces | 0·095 | 1·587 |
| D | *d* | 0·884 | 0·340 | 0·819 | — | — | 0·290 | 0·000 | 0·096 | 2·429 |
| E | *d* | 0·136 | 0·030 | — | — | 0·059 | 0·207 | — | 0·111 | 0·543 |
| Moyennes : | | 0·453 | 0·195 | 0·733 | — | 0·059 | 0·262 | — | 0·100 | 1·519 |
| 30 *centimètres à* 60 *centimètres au-dessous du pivot.* | | | | | | | | | | |
| C | *a* | 0·380 | 0·225 | — | — | — | 0·630 | traces | 0·159 | 1·394 |
| D | *a* | 0·088 | 0·090 | 0·023 | — | — | 1·300 | — | 0·067 | 1·568 |
| E | *a* | 0·141 | — | — | 0·108 | 0·350 | 0·996 | — | 0·111 | 1·712 |
| Moyennes : | | 0·203 | 0·157 | 0·023 | 0·108 | 0·350 | 0·975 | — | 0·112 | 1·558 |
| C | *b* | 1·802 | 0·600 | 1·076 | — | — | 0·810 | traces | 0·111 | 4·399 |
| D | *b* | 0·170 | 0·050 | — | — | 0·160 | 1·745 | 0·000 | 0·067 | 2·194 |
| E | *b* | 0·141 | — | — | 0·018 | 0·134 | 1·069 | — | 0·101 | 1·463 |
| Moyennes : | | 0·704 | 0·325 | 1·076 | 0·018 | 0·147 | 1·208 | 0·000 | 0·093 | 2·685 |
| C | *c* | 1·391 | 0·430 | 1·009 | — | — | 0·190 | 0·000 | 0·079 | 3·102 |
| D | *c* | 0·054 | 0·395 | | — | — | 0·320 | traces | 0·111 | 0·880 |
| E | *c* | 0·081 | 0·085 | 0·230 | — | — | 0·444 | 0·000 | 0·070 | 0·910 |
| Moyennes : | | 0·509 | 0·257 | 0·619 | — | — | 0·318 | 0·000 | 0·085 | 1·630 |
| C | *d* | 1·088 | 0·150 | 1·348 | — | — | 0·500 | 0·000 | 0·095 | 3·181 |
| D | *d* | 0·082 | 0·360 | | indosé | indosé | 0·460 | 0·000 | 0·138 | 1·040 |
| E | *d* | indosé | indosé | indosé | indosé | indosé | 0·290 | traces | 0·079 | 0·870 |
| Moyennes : | | 0·585 | 0·150 | 1·348 | — | — | 0·416 | 0·000 | 0·104 | 1·697 |

TABLEAU VIII.—PARCELLE C. MANCHIA

| | PLANTES NON DEVELOPPEES | | | | PEU DEVELOPPEES | | | |
|---|---|---|---|---|---|---|---|---|
| | *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot | *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot |
| *Pour cent de terre sèche:* | | | | | | | | |
| *Ions:* | | | | | | | | |
| Acide sulfurique ($SO_4$) ... | 0·430 | 0·130 | 0·450 | 1·170 | 0·230 | 0·060 | 0·930 | 2·480 |
| Chlore (Cl) ... ... | 0·520 | 0·210 | 0·320 | 0·380 | 0·750 | 0·190 | 0·620 | 0·490 |
| Acide nitrique ($NO_3$) ... | 0·022 | traces | traces | traces | 0·048 | traces | traces | traces |
| Ac. bicarbonique ($HCO_3$) ... | 0·104 | 0·150 | 0·116 | 0·116 | 0·127 | 0·174 | 0·116 | 0·081 |
| Calcium (Ca) ... ... | 0·090 | 0·016 | 0·032 | 0·112 | 0·048 | 0·024 | 0·080 | 0·530 |
| Magnésium (Mg) ... ... | 0·038 | 0·013 | 0·013 | 0·043 | 0·043 | 0·013 | 0·069 | 0·120 |
| Sodium (Na) ... ... | 0·406 | 0·224 | 0·752 | 0·293 | 0·522 | 0·165 | 0·674 | 0·698 |
| *Combinaisons conventionnelles:* | | | | | | | | |
| Sulfate de calcium ... ... | 0·306 | 0·054 | 0·108 | 0·380 | 0·163 | 0·081 | 0·272 | 1·802 |
| ,, magnésium ... | 0·190 | 0·065 | 0·065 | 0·225 | 0·143 | 0·004 | 0·345 | 0·600 |
| ,, sodium ... ... | 0·091 | 0·057 | 1·541 | — | — | — | 0·683 | 1·076 |
| Chlorure de calcium ... | — | — | — | — | — | — | — | — |
| ,, magnésium ... | — | — | — | — | 0·059 | 0·047 | — | — |
| ,, sodium ... | 0·850 | 0·361 | 0·530 | 0·630 | 1·163 | 0·255 | 1·030 | 0·810 |
| Nitrate de sodium ... ... | 0·030 | traces | traces | traces | 0·066 | traces | traces | traces |
| Bicarbonate ,, ... ... | 0·143 | 0·206 | 0·159 | 0·159 | 0·174 | 0·239 | 0·159 | 0·111 |
| Total des sels solubles ... | 1·610 | 0·743 | 2·403 | 1·394 | 1·768 | 0·626 | 2·489 | 4·399 |
| *Pour cent du résidu sec:* | | | | | | | | |
| Sulfate de calcium ... ... | 19·00 | 7·26 | 4·49 | 27·26 | 9·22 | 12·95 | 10·92 | 40·96 |
| ,, magnésium ... | 11·82 | 8·75 | 2·70 | 16·14 | 8·09 | 0·65 | 13·86 | 13·64 |
| ,, sodium ... ... | 5·65 | 7·67 | 64·15 | — | — | — | 27·44 | 24·46 |
| Chlorure de calcium ... | — | — | — | — | — | — | — | — |
| ,, magnésium ... | — | — | — | — | 3·32 | 7·50 | — | — |
| ,, sodium ... | 52·79 | 48·58 | 22·05 | 45·20 | 65·79 | 40·72 | 41·39 | 18·42 |
| | 1·86 | — | — | — | 3·73 | — | — | — |
| Bicarbonate de sodium ... | 8·88 | 27·74 | 6·61 | 11·40 | 9·85 | 38·18 | 6·39 | 2·52 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Calcaire ($CaCO_3$) (Calcimètre) | 0·98 | 1·11 | 0·57 | 0·88 | 1·19 | 1·19 | 1·30 | 1·1[illegible] |

M BOURY SUD, PRÈS BELCAS (GHARBIA).

| MOYENNEMENT DEVELOPPEES | | | | BIEN DEVELOPPEES | | | |
|---|---|---|---|---|---|---|---|
| *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot | *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot |
| 0·380 | 0·074 | 0·770 | 2·010 | 0·930 | 0·260 | 0·850 | 1·800 |
| 0·470 | 0·080 | 0·080 | 0·110 | 0·460 | 0·065 | 0·170 | 0·310 |
| 0·022 | traces | légères traces | 0·000 | 0·049 | légères traces | légères traces | 0·000 |
| 0·104 | 0·116 | 0·081 | 0·058 | 0·069 | 0·069 | 0·069 | 0·069 |
| 0·040 | traces | 0·056 | 0·410 | 0·190 | 0·056 | 0·100 | 0·320 |
| 0·022 | traces | 0·034 | 0·086 | 0·095 | 0·026 | 0·043 | 0·030 |
| 0·451 | 0·128 | 0·319 | 0·428 | 0·399 | 0·081 | 0·355 | 0·652 |
| 0·136 | traces | 0·190 | 1·394 | 0·646 | 0·190 | 0·340 | 1·088 |
| 0·110 | traces | 0·170 | 0·430 | 0·475 | 0·130 | 0·215 | 0·150 |
| 0·290 | 0·109 | 0·739 | 1·009 | 0·139 | 0·032 | 0·647 | 1·348 |
| — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — |
| 0·780 | 0·130 | 0·130 | 0·190 | 0·710 | 0·110 | 0·290 | 0·500 |
| 0·030 | traces | légères traces | 0·000 | 0·067 | légères traces | légères traces | 0·000 |
| 0·143 | 0·159 | 0·111 | 0·079 | 0·095 | 0·095 | 0·095 | 0·095 |
| 1·489 | 0·398 | 1·340 | 3·102 | 2·132 | 0·557 | 1·587 | 3·181 |
| 9·13 | traces | 14·18 | 44·92 | 29·47 | 34·12 | 21·43 | 34·20 |
| 7·38 | traces | 12·68 | 13·86 | 21·67 | 23·34 | 13·54 | 4·71 |
| 19·47 | 27·39 | 55·16 | 32·56 | 6·34 | 5·74 | 40·78 | 42·38 |
| — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — |
| 52·38 | 32·65 | 9·70 | 6·12 | 35·13 | 19·75 | 18·27 | 15·72 |
| 2·01 | — | — | — | 3·05 | — | — | — |
| 9·63 | 39·96 | 8·28 | 2·54 | 4·34 | 17·05 | 5·98 | 2·99 |
| 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| 0·78 | 1·02 | 1·02 | 1·23 | 0·39 | 0·61 | 1·14 | 1·02 |

## TABLEAU IX.—Parcelle D. Manchia

| | Plantes Non developpees | | | | Peu developpees | | | |
|---|---|---|---|---|---|---|---|---|
| | *a* Crête des billons | *b* Zone des racines | *c* 30 cm. au-des-sous du pivot | *d* 30 à 60 cm. au-des-sous du pivot | *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-des-sous du pivot | *d* 30 à 60 cm. au-des-sous du pivot |
| *Pour cent de terre sèche :* | | | | | | | | |
| *Ions :* | | | | | | | | |
| Acide sulfurique ($SO_4$ ... | 1·440 | 0·090 | 0·950 | 0·150 | 0·200 | 0·390 | 0·290 | 0·160 |
| Chlore (Cl) ... ... | 2·660 | 0·550 | 0·670 | 0·780 | 0·440 | 0·270 | 0·720 | 1·180 |
| Oxide nitrique ($NO_3$) ... | 0·099 | 0·006 | 0·000 | 0·000 | traces | traces | traces | 0·000 |
| Ac. bicarbonique ($HCO_3$) ... | 0·037 | 0·062 | 0 049 | 0·049 | 0 062 | 0·049 | 0 062 | 0·049 |
| Calcium (Ca) .... ... | 0·510 | 0·070 | 0·170 | 0·026 | 0·070 | 0·080 | 0·050 | 0·050 |
| Magnésium (Mg) ... ... | 0·360 | 0·028 | 0·065 | 0 018 | 0·032 | 0 032 | 0·032 | 0·051 |
| Sodium (Na) ... ... | 1·187 | 0·290 | 0·584 | 0·545 | 0·262 | 0·231 | 0 523 | 0·704 |
| *Combinaisons conventionnelles :* | | | | | | | | |
| Sulfate de calcium ... ... | 1·734 | 0·127 | 0·578 | 0·088 | 0·238 | 0·272 | 0·170 | 0·170 |
| ,, magnésium ... | 0·270 | — | 0·365 | 0·090 | 0·040 | 0 160 | 0·160 | 0·050 |
| ,, sodium ... ... | — | — | 0·358 | 0·023 | — | 0·103 | 0·062 | — |
| Chlorure de calcium .... | — | 0·091 | — | — | — | — | — | -- |
| ,, magnésium ... | 1·211 | 0·110 | — | — | 0·095 | — | — | 0 162 |
| ,, sodium... ... | 2·892 | 0·675 | 1·120 | 1·300 | 0·608 | 0·450 | 1·200 | 1·745 |
| Nitrate de sodium ... ... | 0·135 | 0·008 | — | — | traces | traces | traces | 0·000 |
| Bicarbonate de sodium ... | 0·051 | 0·085 | 0·067 | 0·067 | 0 085 | 0·067 | 0·085 | 0·067 |
| Total des sels solubles ... | 6·293 | 1·096 | 2·488 | 1·568 | 1·066 | 1·052 | 1·677 | 2·194 |
| *Pour cent du résidu sec :* | | | | | | | | |
| Sulfate de calcium ... ... | 27·55 | 11·59 | 23·23 | 5·61 | 22·32 | 25·85 | 10·10 | 7·75 |
| ,, magnésium ... | 4·29 | — | 14·66 | 5·74 | 3·75 | 15·21 | 9·54 | 2·27 |
| ,, sodium ... ... | — | — | 14·38 | 1·46 | — | 9·79 | 3·69 | — |
| Chlorure de calcium ... | — | 8·30 | — | — | — | — | — | — |
| ,, magnésium ... | 19·25 | 10·04 | — | — | 8·90 | — | — | 7·38 |
| ,, sodium... ... | 45·96 | 61·59 | 45·04 | 82 92 | 57·06 | 42·78 | 71·60 | 79·55 |
| | 2·14 | 0·73 | — | — | — | — | — | — |
| Bicarbonate de sodium ... | 0·81 | 7·75 | 2·69 | 4·27 | 7·97 | 6·37 | 5·07 | 3·05 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Calcaire ($CaCO_3$) (Calcimètre) | 0·64 | 1·35 | 0·53 | 0·64 | 0·88 | 0·86 | 0·66 | 1·06 |

o. 3 CHARKIA, PRÈS BELCAS (GHARBIA).

| MOYENNEMENT DEVELOPPEES | | | | BIEN DEVELOPPEES | | | |
|---|---|---|---|---|---|---|---|
| *a* Crête des billons | *b* Zone des racines | *c* o à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot | *a* Crête des billons | *b* Zone des racines | *c* o à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot |
| 0·180 | 0·280 | 0·610 | 0·300 | 0·170 | 0·200 | 1·450 | 0·330 |
| 0·300 | 0·260 | 0·240 | 0·180 | 0·530 | 0·056 | 0·170 | 0·270 |
| traces | traces | 0·000 | 0·000 | traces | traces | 0·000 | 0·000 |
| 0·070 | 0·081 | 0·081 | 0·081 | 0·070 | 0·081 | 0·070 | 0·105 |
| 0·032 | 0·020 | 0·048 | 0·016 | non dosé | 0·048 | 0·260 | 0·025 |
| 0·021 | 0·026 | 0·042 | non dosé | 0·034 | 0·013 | 0·068 | non dosé |
| 0·235 | 0·251 | 0·336 | — | — | 0·083 | 0·411 | — |
| 0·108 | 0·068 | 0·163 | 0·054 | — | 0·163 | 0·884 | 0·082 |
| 0·105 | 0·130 | 0·210 | } 0·395 | 0·170 | 0·065 | 0·340 | — |
| 0·029 | 0·189 | 0·483 | | 0·354* | 0·049 | 0·819 | — |
| — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — |
| 0·500 | 0·420 | 0·390 | 0·320 | 0·880 | 0·093 | 0·290 | 0·640 |
| traces | traces | 0·000 | 0·000 | traces | traces | 0·000 | 0·000 |
| 0·096 | 0·111 | 0·111 | 0·111 | 0·096 | 0·111 | 0·096 | 0·318 |
| 0·838 | 0·918 | 1·357 | 0·880 | 1·400 | 0·481 | 2·429 | 1·040 |
| 12·88 | 7·47 | 12·01 | — | — | 33·88 | 36·39 | — |
| 12·53 | 14·16 | 15·47 | — | — | 13·51 | 13·99 | — |
| 3·46 | 20·58 | 35·59 | — | — | 10·18 | 33·74 | — |
| — | — | — | — | — | — | — | — |
| — | — | — | — | — | — | — | — |
| 59·68 | 45·70 | 28·75 | — | — | 19·35 | 11·93 | — |
| — | — | — | — | — | — | — | — |
| 11·45 | 12·09 | 8·18 | — | — | 23·08 | 3·95 | — |
| 100·0 | 100·0 | 100·0 | — | — | 100·0 | 100·0 | — |
| 0·45 | 0·70 | 2·09 | 0·53 | 1·14 | 0·61 | 0·78 | 1·00 |

* Somme du sulfate de sodium et du sulphate de calcium.

## TABLEAU X.—PARCELLE E. MANCHIA

| | PLANTES NON DEVELOPPEES | | | | PEU DEVELOPPEES | | | |
|---|---|---|---|---|---|---|---|---|
| | *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot | *a* Crête des billons | *b* Zone des racines | *c* 0 à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot |
| *Pour cent de terre sèche:* | | | | | | | | |
| *Ions:* | | | | | | | | |
| Acide sulfurique ($SO_4$) ... | 0·626 | 0·156 | 0·445 | 0·100 | 0·490 | 0·346 | 0·740 | 0·100 |
| Chlore (Cl) ... ... | 4·860 | 1·020 | 0·760 | 0·940 | 2·610 | 0·710 | 0·540 | 0·760 |
| Acide nitrique ($NO_3$) ... | 0·0011 | traces | traces | traces | 0·0011 | traces | traces | traces |
| Ac. bicarbonique ($HCO_3$) ... | 0·070 | 0·058 | 0·058 | 0·081 | 0·058 | 0·081 | 0·104 | 0·074 |
| Calcium (Ca) ... ... | 0·580 | 0·096 | 0·080 | 0·080 | 0·400 | 0·048 | 0·088 | 0·048 |
| Magnésium (Mg) ... ... | 0·432 | 0·070 | 0·090 | 0·090 | 0·237 | 0·043 | 0·073 | 0·034 |
| Sodium (Na) ... ... | 1·9794 | 0·511 | 0·461 | 0·421 | 1·0304 | 0·518 | 0·502 | 0·447 |
| *Combinaisons conventionnelles:* | | | | | | | | |
| Sulfate de calcium ... | 0·886 | 0·221 | 0·272 | 0·141 | 0·693 | 0·163 | 0·299 | 0·141 |
| ,, magnésium ... | — | — | 0·316 | — | — | 0·215 | 0·365 | — |
| ,, sodium ... | — | — | — | — | — | 0·087 | 0·350 | — |
| Chlorure de calcium ... | 0·888 | 0·086 | — | 0·108 | 0·546 | — | — | 0·018 |
| ,, magnésium ... | 1·710 | 0·277 | 0·107 | 0·356 | 0·938 | — | — | 0·134 |
| ,, sodium ... | 4·967 | 1·248 | 1·120 | 0·996 | 2·569 | 1·170 | 0·890 | 1·069 |
| Nitrate de sodium... ... | 0·0015 | traces | traces | traces | 0·0015 | traces | traces | traces |
| Bicarbonate de sodium ... | 0·096 | 0·079 | 0·079 | 0·111 | 0·079 | 0·111 | 0·143 | 0·101 |
| Total des sels solubles... | 8·5485 | 1·911 | 1·894 | 1·712 | 4·8265 | 1·746 | 2·047 | 1·463 |
| *Pour cent du residu sec:* | | | | | | | | |
| Sulfate de calcium ... | 10·36 | 11·63 | 14·36 | 8·23 | 14·35 | 9·33 | 14·61 | 9·67 |
| ,, magnésium ... | — | — | 16·68 | — | — | 12·31 | 17·83 | — |
| ,, sodium ... | — | — | — | — | — | 4·98 | 17·09 | — |
| Chlorure de calcium ... | 10·37 | 4·50 | — | 6·31 | 11·31 | — | — | 1·23 |
| ,, magnésium ... | 20·00 | 14·49 | 5·65 | 20·79 | 19·43 | — | — | 9·16 |
| ,, sodium ... | 58·13 | 65·25 | 59·14 | 58·18 | 53·25 | 67·02 | 43·49 | 73·04 |
| | 0·02 | — | — | — | 0·03 | — | — | — |
| Bicarbonate de sodium ... | 1·12 | 4·13 | 4·17 | 6·49 | 1·63 | 6·36 | 6·98 | 6·90 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |
| Calcaire ($CaCO_3$) (calcimètre) | 0·74 | 1·02 | 0·98 | 1·11 | 0·90 | 1·02 | 1·68 | 0·70 |

No. 2. Baharia, près Belcas (Gharbia).

| Moyennement developpees | | | | Bien developpees | | | |
|---|---|---|---|---|---|---|---|
| *a* Crête des billons | *b* Zone des racines | *c* o à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot | *a* Crête des billons | *b* Zone des racines | *c* o à 30 cm. au-dessous du pivot | *d* 30 à 60 cm. au-dessous du pivot |
| 0·206 | 0·100 | 0·091 | 0·281 | 0·214 | 0·024 | 0·120 | 0·240 |
| 0·090 | 0·200 | 0·200 | 0·270 | 0·550 | 0·088 | 0·170 | 0·175 |
| traces | traces | 0·000 | 0·000 | 0·0071 | traces | 0·000 | traces |
| 0·104 | 0·104 | 0·081 | 0·058 | 0·070 | 0·081 | 0·081 | 0·058 |
| 0·040 | 0·024 | 0·048 | 0·024 | 0·056 | 0·032 | 0·040 | 0·008 |
| 0·021 | 0·017 | 0·026 | 0·017 | 0·043 | 0·017 | 0·021 | non dosé |
| 0·107 | 0·154 | 0·097 | 0·260 | 0·3396 | 0·030 | 0·111 | — |
| 0·136 | 0·081 | 0·128 | 0·081 | 0·190 | 0·034 | 0·136 | |
| 0·105 | 0·053 | — | 0·085 | 0·100 | — | 0·030 | |
| 0·038 | — | — | 0·230 | — | — | — | |
| — | — | 0·030 | — | — | 0·060 | — | |
| — | 0·028 | 0·103 | — | 0·091 | 0·067 | 0·059 | |
| 0·146 | 0·294 | 0·171 | 0·444 | 0·793 | — | 0·207 | |
| traces | traces | 0·000 | 0·000 | 0·0097 | traces | — | |
| 0·143 | 0·143 | 0·111 | 0·070 | 0·096 | 0·111 | 0·111 | |
| 0·568 | 0·599 | 0·543 | 0·910 | 1·2797 | 0·272 | 0·543 | |
| 23·94 | 13·52 | 23·57 | 8·90 | 14·84 | 12·50 | 25·04 | |
| 18·48 | 8·84 | — | 9·33 | 7·81 | — | 5·52 | |
| 6·69 | — | — | 25·27 | — | — | — | |
| — | — | 5·52 | — | — | 22·05 | — | |
| — | 4·67 | 18·96 | — | 7·11 | 24·63 | 10·86 | |
| 25·70 | 49·10 | 31·49 | 48·81 | 61·99 | — | 38·14 | |
| — | — | 0·00 | 0·00 | 0·75 | — | — | |
| 25·19 | 23·87 | 20·46 | 7·69 | 7·50 | 40·82 | 20·44 | |
| 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | |
| 0·70 | 1·40 | 1·25 | 0·12 | 0·94 | 1·31 | 1·35 | 0·33 |

ailleurs, le cotonnier est sensible aux effets des sels quand ceux-ci dépassent une certaine quantité.

Les rendements sont, toutes choses égales d'ailleurs et dans certaines limites, inversement proportionnels à la dose de sels nuisibles que renferme la terre. Il s'agit seulement de ne considérer que la couche réellement en contact avec les racines. On trouve ainsi que ce sont les terres qui ne renferment guère plus de 0·30 pour cent de sels nuisibles qui donnent les meilleurs rendements. La terre adhérente aux racines des cotonniers de la parcelle E (E*d*), qui donne 4 à 5 kantars au feddan ne contenait que 0·272 pour cent de sels solubles sur lesquels il y avait 0·034 pour cent de sulfate de calcium, dont j'ai déjà rappelé l'action bienfaisante. Cette action est encore beaucoup plus manifeste dans le cas des terres C*d* et D*d*.

Dans l'ensemble, la dose totale des sels solubles pour les terres qui produisent de 3 à 5 kantars ne dépasse guère 0·43 dont 0·13 de sulfate de calcium et 0·30 de sels nuisibles. Dès que cette dose dépasse 0·5 ou 0·6 pour cent les rendements baissent et à 1 pour cent ils deviennent pratiquement nuls. Ce dernier point est mis en évidence, aussi bien par l'analyse de la couche de terre adhérente aux racines des plantes dans les types de végétation (*a*), (*b*), (*c*), (*d*), que par l'examen de la couche qui vient immédiatement après.

Il faut noter cependant que dans cette investigation les sels nuisibles consistaient en sulfate de magnésium et de sodium, en chlorures de calcium, magnésium et sodium et enfin en bicarbonate de ce dernier métal. Les solutions salines du sol présentent ici un caractère qui diffère de celui qu'elles revêtent dans le Sud et le Centre du Delta, en ce qui concerne la nature et la proportion des différents sels qui les constituent. Les parcelles étudiées ne contenaient pas de carbonate de sodium.

La terre de la parcelle E nous fournit une bonne occasion pour étudier l'action individuelle des chlorures en présence d'une faible quantité de sulfate de calcium et en présence d'une dose normale de bicarbonate de sodium. On voit que, lorsque la dose de chlorures passe de 0·13 à 0·32 pour cent, le rendement de 4 à 5 kantars tombe à 1 ou 2 environ. Il semblerait, toutefois, d'après ces chiffres et ceux que j'ai obtenus depuis, que les cotonniers supportent une dose légèrement plus élevée de chlorures et de sels nuisibles en général, dans le Nord que dans le Centre et le Sud du Delta.

Cela est dû, sans doute, au fait que pour une même dose de sels, les solutions qui circulent au sein des terres sont, en général, pour différentes raisons, plus diluées dans le Nord que dans le Centre et contiennent ordinairement et proportionnellement plus de sulfate de calcium.

Ce dernier point se confirme si l'on considère la terre adhérente aux racines et que l'on compare entre eux les chiffres relatifs à la parcelle C*c*, sans sulfate de calcium, avec les chiffres des parcelles D*c* et E*c*, contenant ce sulfate.

Le cotonnier, à en juger par ces dosages et par plusieurs autres également, semble supporter d'assez grandes quantités de sulfate de sodium. Les bicarbonates varient peu entre les différentes terres des divers types de végétation. Ils sont plus abondants dans la couche exploitée par les racines que sur la crête des billons où se sont accumulés les sels solubles.

Pour la région du Nord du Delta, en l'absence du carbonate de sodium, les chlorures et sulfates de magnésium et de sodium sont en réalité ceux dont il faut le plus tenir compte, et ces recherches montrent que pour apprécier le degré de leur toxicité il importe de prendre en considération leurs proportions respectives ainsi que la présence ou l'absence du sulfate de calcium.

Or, comme on peut le voir, ces proportions sont très variables, et différentes pour les diverses terres. La somme des sels solubles peut ainsi varier dans de grandes limites.

Dans les expériences qui nous occupent, le carbonate de sodium était absent. Je l'ai trouvé par contre dans plusieurs autres localités, principalement dans la Béhéra.[19] Je n'ai pas à revenir ici sur ce que j'ai dit à son sujet. J'ajouterai simplement qu'en raison de la nature plus argileuse des terres du Nord (Bararis), le carbonate

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[19] Voir Mosséri.—" Les Terrains alcalins en Egypte," *Bull. Institut Egyptien,* tome v, 1911.

peut y produire les mêmes effets nuisibles à doses bien moindres.

Un autre fait intéressant se dégage de ces analyses. C'est l'ascension des sels à la surface des billons au profit de la zone exploitée par les racines. Les chlorures forment plus de la moitié des sels ainsi accumulés. Par suite de cette accumulation, il est difficile de fixer par des chiffres les limites de salure compatibles avec tel ou tel rendement dans ces régions des Bararis (terres salées du Nord). Ces limites varient suivant la nature des sels qui constituent le total soluble et aussi et surtout suivant les conditions culturales, climatériques, agrologiques et autres qui déterminent la dilution et l'ascension précitées.

Cette ascension justifie les pratiques et artifices adoptés par les cultivateurs des régions plus ou moins salées de la partie septentrionale de l'Egypte. Ici, en effet, les billons sont peu élevés et les raies d'arrosage évasées. J'ai montré que dans ce cas, l'imbibition est moins profonde et d'une portée latérale plus grande, ce qui empêche la capillarité de puiser les sels dans les profondeurs du sous-sol et facilite l'accumulation des sels du sol à la surface des billons ou *mastabah.* Les graines sont semées au bas du versant Sud des billons, presque dans les raies. On sème plus dru. La durée du premier assoiffement ou *tââtiché* y est de 40 à 45 jours au lieu de 30 à 35 comme dans le Centre et le Sud du Delta. Cela toujours pour que la terre où s'enfonce la jeune racine puisse envoyer son excès de sels sur la crète des billons. Les arrosages y sont pratiqués non pas en rapport avec les besoins réels des plantes, mais en vue de diluer constamment les solutions salines qui circulent autour des racines, etc.

Il était intéressant de montrer que ces pratiques culturales se justifient scientifiquement, ce qui ne signifie point qu'elles soient parfaites. La vraie solution, en effet, est de dessaler la terre sur une profondeur convenable, afin de la mettre en état d'être semée de bonne heure et cultivée suivant les méthodes les plus rationnelles.

Dans cette première investigation, la végétation et les rendements du cotonnier ont été, jusqu'à un certain point, proportionnels à l'épaisseur de la tranche dessalée, pouvant être utilisée par les racines. Cette épaisseur n'a pu être inférieure à 50 ou 60 centimètres sans affecter défavorablement les résultats culturaux. Des recherches ultérieures m'ont montré que cette tranche, compatible avec un développement normal du cotonnier, a en réalité une épaisseur qui est le résultat combiné de plusieurs facteurs, tels que la nature des terres, leur salure, celle des eaux souterraines, les conditions climatériques, la préparation du sol, les façons de culture, les arrosages, les caractères individuels, etc. On comprend, dès lors, que cette épaisseur ne saurait être la même partout.

La connaissance exacte de sa valeur minimum pourtant est indispensable pour décider du niveau auquel il convient de maintenir le plan d'eau dans des drains et fixer les conditions générales du drainage. Des expériences multiples restent encore à faire pour déterminer cette épaisseur suivant les localités.

Toutefois, les recherches de M. Audebeau Bey,[20] celles de M. Ferrar[21] et les études de M. Balls[22] ont fait voir qu'en général pour le Centre et le Sud du Delta, ainsi que pour la province de Ghiza, une épaisseur minimum de terre sèche d'environ 2m. est indispensable à un bon rendement cotonnier. Contrairement à ce qui se passe dans les régions du Nord du Delta, les eaux du sous-sol dans le Sud et dans une partie du Centre, contribuent, dans une certaine mesure, aux besoins du cotonnier en eau pendant la période d'étiage. J'ai parlé de cette source d'alimentation dans une étude récente, à laquelle je renvoie.[23]

Mes expériences dans les régions du Nord du Delta, à sous-sol plus ou moins salé, expériences que confirment

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[20] Rapport à l'Administ. des Domaines de l'Etat, 1909-1912.

[21] "The Effect of Water on the Cultivation of Cotton," *Survey Paper* No. 24, 1912.

[22] "The Cotton Plant in Egypt," 1912.

[23] "L'Utilisation du Réservoir souterrain," *Bull. Institut Egyptien, Avril,* 1914; et *Bull. de l'Union des Agriculteurs d'Egypte,* 1914, p. 79.

du reste les observations culturales, montrent qu'il suffit ordinairement dans ces régions que le plan d'eau soit maintenu à une profondeur de 1m. 25 à 1m. 50 pour satisfaire amplement au développement normal du cotonnier.[24] J'ai signalé d'autre part qu'on peut obtenir dans ces régions septentrionales du Delta jusqu'à cinq et six kantars de coton au feddan, avec un plan d'eau maintenu à 70 ou 80 centimètres, au-dessous du sol, à la condition que ce plan ne subisse point de fluctuations appréciables et subites durant la culture cotonnière.[25]

Cependant, à cause des sels nuisibles du sous-sol et si l'on ne veut point revenir tous les deux ans à la culture du riz que la remontée des sels rendrait obligatoire, il est indispensable de maintenir le plan des eaux souterraines à 1m. 25 ou 1m. 50 de profondeur. Il ne paraît pas utile d'abaisser davantage ce niveau, afin de ne point favoriser le développement *à bois* et retarder la maturité des capsules. D'ailleurs le système radiculaire du cotonnier sous l'influence des conditions de température du Nord du Delta, s'accomode parfaitement d'une moindre profondeur. Les fluctuations de la nappe souterraine sont en réalité plus intéressantes que son niveau absolu, lorsque celui-ci reste dans les limites précitées. En effet, si dans leurs fluctuations les eaux souterraines parviennent à atteindre les racines des plantes, elles amènent l'asphyxie de la partie envahie, et chez le cotonnier elles provoquent une chute anormale des capsules accompagnée d'une diminution de la résistance des fibres. Dans le région des Bararis, les fluctuations sont provoquées principalement par les arrosages.[26]

Comme on le voit, la question des sels est intimement liée à celle du drainage et des eaux souterraines et l'on ne peut point envisager l'une sans prendre l'autre en considération.

Des recherches analogues à celles de 1907 ont été étendues en 1909 à toute la région de Kafr el Garaida, près Belcas (Gharbia), comprise entre le canal Bishma et le

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24 "Le Drainage en Egypte," *loc. cit.*

25 *Cairo Scientific Journal*, vol. iii, p. 507.

26 Mosséri, V.—"Le Drainage en Egypte," *loc. cit.*

drain Banaouan. Quatre localités ont été observées: (1) Garaida haute, très bonne terre, cote + 3m., à rendement normal de 6 kantars au feddan, à eaux souterraines fluctuant entre 1m.50 et 1m. (2) Garaida basse, bonne terre, cote + 2·50 à rendement habituel de 4 à 4½ kantars et où les eaux souterraines se trouvaient à une profondeur variable entre 1m. et 0m.83. (3) Manchia (Hod el Zeraia), assez bonne terre située à la côte + 1·80, donnant d'ordinaire 3 à 4 kantars et où les eaux souterraines se maintennant entre 0m.58 et 0m.60 de la surface. (4) Manchia (No. 3 Baharia), mauvaise terre cote + 1·20 ne produisant que 1 à 2 kantars; eaux souterraines à 0m.87 et 0m.90.

Des plantes des quatre qualités de terres ont été, après la deuxième cueillette, extraites du sol avec leurs racines, en prenant des précautions spéciales à cet effet.

La teneur en sels de ces quatre terres de différente productivité, confirme les données précédemment obtenues. (Voir Tableau XI.)

D'autres déterminations faites sur des terres de différentes régions ont toujours donné les mêmes résultats. Je me dispense de les relater ici, car elles ne diront rien de plus que les chiffres déjà énoncés.

Des essais poursuivis depuis 1911 en vue de déterminer le degré de résistance que peuvent opposer les variétés de cotonniers cultivées en Egypte, aux effets des sels, n'ont pas encore conduit à des résultats précis. Cependant le Sakellaridis paraît être la variété la mieux adaptée aux terres plus ou moins salées du Nord du Delta et aux conditions climatériques de cette région si l'on en juge par ces essais ainsi que par les résultats pratiques obtenus en grande culture. Néanmoins des recherches supplémentaires sont encore nécessaires avant de se prononcer définitivement sur ce point et sur le degré de tolérance de chacune des autres variétés.

Enfin, dans une autre série d'études, j'ai essayé de préciser de quelle façon se traduit sur la végétation du cotonnier et sur ses produits, l'action des sels nuisibles à doses moyennes. Pour cela on a choisi à Manchia Kafr el Garaïda (Gharbia) trois parcelles soumises aux

# TABLEAU XI.

## TERRES A COTON DE KAFR EL GARAIDA (GHARBIA).

| Eléments solubles pour cent terre sèche | Très bonne terre Geraida haute (rendement 6 kantars) | | | Bonne terre Garaida basse (rendement 4 à $4\frac{1}{2}$ kantars) | | Assez bonne terre Hod Zeraiia (rendement 4 kantars) | | Terre médiocre No. 3 Baharia (rendement 1 à 2 kantars) | |
|---|---|---|---|---|---|---|---|---|---|
| | 0 à 30 cm. | 30 à 60 cm. | 60 à 90 cm. | 0 à 30 cm. | 30 à 60 cm. | 0 à 30 cm. | 30 à 60 cm. | 0 à 30 cm. | 30 à 60 cm. |
| Acide sulfurique ($SO_4$) ... ... | 0·040 | non dosé | non dosé | 0·140 | 0·400 | 0·490 | 0·620 | 0·007 | 0·530 |
| Chlore (Cl) ... ... ... | 0·024 | 0·024 | 0·054 | 0·054 | 0·072 | 0·042 | 0·054 | 0·190 | 0·310 |
| Acide carbonique ($CO_3$) ... | néant | néant | néant | néant | néant | néant | néant | néant | néant |
| ,, bicarbonique ($HCO_3$) ... | 0·148 | 0·186 | 0·136 | 0·161 | 0·161 | 0·099 | 0·099 | 0·086 | 0·099 |
| Calcium (Ca) ... ... ... | non dosé | non dosé | non dosé | 0·008 | non dosé | 0·120 | 0·080 | 0·008 | 0·064 |
| Magnésium (Mg) ... ... | non dosé | non dosé | non dosé | traces | non dosé | 0·030 | 0·030 | traces | 0·030 |
| Résidu sec ... ... | 0·300 | 0·340 | 0·380 | 0·440 | 0·880 | 0·940 | 1·060 | 0·590 | 1·460 |

*Diagrams to face this page.*

mêmes conditions de culture, de drainage et d'irrigation. Toutes les trois sont constituées par des terres à peu près semblables qui diffèrent entre elles par leur teneur en sels nuisibles. La première et la seconde de ces parcelles représentent le type de terres légèrement salées (0·7 pour cent de sels solubles dont 0·15 et 0·2 de NaCl), se trouvant à la cote + 1m. 41 et 1m. 19 respectivement. La troisième est à la cote + 0m. 80 et représente le type de terres assez salées (0·856 pour cent de sels solubles dont 0·5 environ de NaCl). Les eaux souterraines subissaient dans les trois champs à peu près les mêmes fluctuations et atteignaient le même niveau.

Soixante-quinze poquets ont été convenablement choisis dans chacune des parcelles : le nombre des capsules a été relevé tous les huit jours. A la première et à la seconde cueillette on a compté les capsules et pesé leur coton. On a ensuite déterminé le rendement à l'égrenage ainsi que le poids des graines. On en a déduit le poids de coton produit par cent graines ou ce que Cook a désigné sous le nom de *lint index* ou "*indice-fibre.*" (Voir Tableau XII.)

On peut conclure de ces essais que les sels exercent leur action nuisible sur le cotonnier, non seulement en diminuant le nombre de capsules par plante, mais aussi le poids de coton-graine par capsule. Si le rendement à l'égrenage reste plus ou moins le même pour les cotons des diverses parcelles, par contre le poids des graines est plus élevé sur les bonnes terres et partant le "lint index." Sur les terres salées la récolte est plus tardive et les graines de la première cueillette ne sont pas suffisamment mûres, quoiqu'il ne faille pas accorder une valeur absolue aux pourcentages respectifs de deux cueillettes, parce que celles-ci ont été faites à des époques qui ont dépendu plutôt de l'appréciation personnelle des cultivateurs.

La différence entre le poids des capsules et des graines de la première et celui des capsules et des graines de la deuxième cueillette tend à démontrer que les fibres ou poils de la première cueillette ne sont pas assez mûres, ce que démontre du reste l'expertise commerciale.

Les fibres ont été moins régulières sur la terre la plus chargée de sels.

## TABLEAU XII.

Effets des sels nuisibles sur les rendements cotonniers.

| Observations relatives à 75 poquets | Parcelle A cote + 1m. 40 légèrement salée | Parcelle B cote + 1m. 19 moyennement salée | Parcelle C cote + 0m. 80 assez salée |
|---|---|---|---|
| Date des semailles ... ... | 16 avril, 1910 | 23 avril 1910 | 26 avril, 1910 |
| Date de la 1e cueillette ... | 9 octobre, 1910 | 20 octobre, 1910 | 20 octobre, 1910 |
| Nombre des capsules récoltées à la 1e cueillette | 1,162 | 902 | 423 |
| Poids de coton-graine récolté à la 1e cueillette | 2,640 gr. | 1,850 gr. | 620 gr. |
| Date de la 2e cueillette ... ... | 27 octobre, 1910 | 11 novembre, 1910 | 11 novembre, 1910 |
| Nombre des capsules récoltées à la 2e cueillette | 434 | 313 | 593 |
| Poids de coton-graine récolté à la 2e cueillette | 952 gr. | 657 gr. | 1,203 gr. |
| Nombre total de capsules récoltées (sur 75 poquets) | 1,596 | 1,215 | 1,016 |
| Poids total de coton-graines récolté (sur 75 poquets) | 3,592 gr. | 2,507 gr. | 1,823 gr. |
| Poids de coton-graine par capsule de 1e cueillette | 2 gr. 27 | 2 gr. 05 | 1 gr. 46 |
| Poids de coton-graine par capsule de 2e cueillette | 2 gr. 19 | 2 gr. 09 | 2 gr. 02 |
| Poids-moyen de coton-graine par capsule | 2 gr. 25 | 2 gr. 06 | 1 gr. 79 |
| Rendement à l'égrenage de la 1e cueillette en pour cent de coton | 34·43 pour cent | 35·40 pour cent | 34·01 pour cent |
| Rendement à l'égrenage de la 2e cueillette en pour cent de coton | 34·08 ,, | 34·36 ,, | 34·08 ,, |
| Pourcentage de la 1e cueillette du total récolté | 73·50 ,, | 73·70 ,, | 34·0 ,, |
| Lint-index (1e cueillette) ... | 5·96 | 5·65 | 5·48 |
| Qualité marchande (classification) | Fully good fair | Fully good fair | Fair |
| Prix ... ... ... | 18 à 18½ talaris par kantar | 18 à 18½ talaris par kantar | 16 talaris par kantar |

La qualité marchande a passé du fully good fair pour les cotons des bonnes terres au fair pour celui des terres plus salées.

Les prix ont été de 18½ et 16 talaris par kantar pour les deux cas respectivement: soit une différence de 2 talaris et ½ en faveur des terres dessalées.

Ces données ont été du reste confirmées par des expériences ultérieures.

## Conclusions.

Si des doses minimes de sels et spécialement de chlorure de sodium peuvent exercer une action favorable, ces doses, dès qu'elles dépassent une certaine limite, nuisent incontestablement à la quantité et à la qualité des produits. Ces limites varient suivant de nombreux facteurs que j'ai essayé de préciser.

Cette action nuisible se manifeste aussi bien dans le Sud que dans le Nord de l'Egypte. Seulement dans les régions septentrionales, un climat plus frais, une plus grande humidité du sol, une nappe souterraine salée à niveau plus élevée, un système radiculaire plus traçant, des pratiques et artifices culturaux appropriés, etc., font que les plantes se contentent d'une couche dessalée de moindre épaisseur.

Si dans le Sud et le Centre, la tranche utile, sèche et dessalée, nécessaire au développement normal du cotonnier, ne saurait être inférieure à 2m., dans le nord (Bararis) il n'est pas nécessaire d'abaisser à plus de 1m.25 à 1m. 50 le plan des eaux souterraines. C'est la quantité de sels contenus dans cette tranche dont on doit tenir compte. On ne peut néanmoins juger de leur influence que si l'on connaît exactement leur nature et la proportion de chacun d'eux.

J'ai montré combien le cotonnier était sensible à l'action du carbonate de sodium, ou alcali noir, même à doses très minimes, d'autant plus minimes que les terres sont plus argileuses.

Les apparitions fugitives de ce carbonate, sur lesquelles j'ai insisté dans un autre travail, sont à craindre au cours de la végétation et il est nécessaire de veiller sur les conditions qui peuvent les déterminer.

En général et surtout en terres plus ou moins calcaires, on en est averti par une dose trop élevée de bicarbonate.

Après le carbonate alcalin, les chlorures constituent, avec le sulfate de magnésium, les sels les plus nuisibles.

Viennent enfin le sulfate et le bicarbonate de sodium. J'ai relevé les doses limites compatibles avec des rendements normaux. Ces doses sont notablement inférieures à celles qu'on admet d'ordinaire.

J'ai montré ensuite de quelle manière les sels exercent leur action nuisible sur le rendement et sur la qualité des produits.

Toutes les recherches ont été effectuées sur des cultures en pleins champs ne s'écartant pas des conditions normales. Elles ont été multipliées de façon à éliminer autant que possible l'influence des facteurs étrangers.

Ces investigations n'ont pas seulement un intérêt spéculatif : elles sont très précieuses dans un pays comme l'Egypte, où la question des sels est intimement liée à celle de la fertilité du sol. Les résultats obtenus expliquent certaines anomalies observées quelquefois dans les expériences de fumure. Dans beaucoup de cas, ils rendent compte de la différence de productivité que l'on constate entre deux terres parfois contigues, en apparence semblables.

Les données qui se dégagent de ces recherches trouvent leur application directe dans la mise en valeur des Bararis, ou terres salées incultes du Nord du Delta.

Or, dans ces quinze dernières années, la superficie annuellement cultivée en coton a passé de 1,000,000 de feddans environ à plus de 1,300,000 dans la Basse-Egypte, et de 88,000 à 380,000 dans la Haute-Egypte.

Dans cette dernière région, l'augmentation est spécialement due à la conversion des bassins de la Moyenne-Egypte. Dans la Basse-Egypte elle est le résultat, en partie, de la substitution de l'assolement biennal à l'assolement triennal, et, en partie de la mise en valeur des terres incultes, particulièrement des Bararis. On estime qu'il y a environ 1,000,000 de feddans de ces Bararis en voie d'amélioration et 1,200,000 encore en friche. Avec la conversion des bassins restants dans la Haute-Egypte et la mise en culture des Bararis, on pourra augmenter de plus de 50 pour cent la superficie actuellement consacrée au coton dans ce pays. Mais tandis que les terres de la Haute-Egypte ne pourront produire que du coton Ashmouni, qui devra soutenir la concurrence avec la canne à sucre, les Bararis seront susceptibles de donner les variétés les plus fines parmi celles qui font la renommée du coton égyptien.

# NOTE PRELIMINAIRE SUR LES ENGRAIS CHIMIQUES DANS LA CULTURE DU COTONNIER EN EGYPTE.

Par Victor M. Mosséri.

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Depuis quelques années, des conditions économiques nouvelles, imposent à l'agriculture égyptienne l'obligation d'accroître de plus en plus les rendements tout en abaissant les prix de revient.

De là, sont nées des pratiques relativement récentes, parmi lesquelles la fumure intensive du sol.

Pour se procurer les matières fertilisantes que son cheptel vivant ne suffit plus à lui fournir, le cultivateur a dû s'adresser aux engrais, et plus spécialement aux engrais chimiques, qui, à peine connus il y a une dizaine d'années, sont aujourd'hui l'objet d'un commerce important.

En 1913 l'Egypte en a consommé les quantités suivantes :—

| | Tonnes |
|---|---|
| Nitrate de soude ... ... ... ... | 56,922 |
| Superphosphate ... ... ... ... | 12,704 |
| Cyanamide de chaux ... ... ... ... | 969 |
| Sulfate d'ammoniaque ... ... ... ... | 562 |
| Sulfate de potasse ... ... ... ... | 255 |
| Autres engrais ... ... ... ... ... | 240 |
| Total ... | 71,652 |

Malgré les essais qui ont été faits dans ce pays en vue d'étudier la fumure rationnelle des plantes qui y sont cultivées, il faut avouer qu'en dehors de quelques cas-peu nombreux du reste—la question n'a pas beaucoup avancée.

En ce qui concerne le cotonnier, on n'a pas encore abouti jusqu'ici à des conclusions générales et précises. D'après les expériences que je poursuis depuis 1903, en diverses localités, il faudrait attribuer cet insuccès à un défaut de continuité dans les recherches.

Il est rare aussi que l'on prenne les précautions nécessaires pour éviter l'action des facteurs étrangers, dont l'influence est souvent plus considérable que celle des engrais employés.

Il est difficile, en effet, d'obtenir pour les différentes parcelles d'un champ d'expériences des conditions identiques en ce qui concerne l'homogénéité des terres, les arrosages, les attaques des parasites animaux ou végétaux, la répartition des sels solubles, le drainage, les oscillations des eaux souterraines, les cultures et fumures antérieures, le voisinage de plantations arbustives, la préparation du sol et les façons culturales, les réensemencements, la proximité d'un drain, d'un canal, d'une rigole en charge, etc.

Dans la fumure du cotonnier, le problème se complique aussi du fait que tout en cherchant à augmenter le rendement, il est essentiel de respecter la qualité des fibres, qualité que l'on devrait plutôt chercher à améliorer.

Pour toutes ces raisons, j'ai, depuis 1912, introduit dans mes essais les méthodes adoptées ailleurs en vue de réduire le plus possible les erreurs expérimentales. A cet effet, je me suis inspiré des travaux de Wood et Stratton[1] et de ceux de Mercer et Hall.[2]

Je me propose d'exposer ici les résultats obtenus par cette voie en 1912 et 1913 à Bata (Menoufia), et en 1913 à Kafr-Soliman (Gharbia).

J'envisagerai plus particulièrement les effets des engrais chimiques. Les parcelles choisies dans les localités précitées représentent le type des bonnes terres que l'on rencontre dans le sud (Bata) et dans le centre du Delta (Kafr-Soliman), comme l'indiquent l'analyse chimique et physique des terres de ces parcelles, ainsi que le dosage des sels solubles qu'elles contiennent. (Voir Tableaux I et II.)

A Bata, comme à Kafr-Soliman, les eaux souterraines se trouvaient à plus de 2 mètres au-dessous de la surface du sol; il n'y avait pas lieu dès lors d'en tenir compte.

Pour éviter des répétitions, voici quels ont été les

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[1] *Journal of Agricultural Science*, vol. iii, 1910, p. 417.
[2] *Ibid.*, vol. iv, 1911, p. 106.

# TABLEAU I.

KAFR-SOLIMAN

| Eléments solubles pour cent terre sèche | Parcelle No. 1. | | | Parcelle No. 2 | | | Parcelle No. 3 | | | Parcelle No. 4. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 à 30 | 30 à 60 | 60 à 90 | 0 à 30 | 30 à 60 | 60 à 90 | 0 à 30 | 30 à 60 | 60 à 90 | 0 à 30 | 30 à 60 | 60 à 90 |
| Résidu sec ... ... | 0·10 | 0·10 | 0·14 | 0·14 | 0·16 | 0·22 | 0·22 | 0·22 | 0·38 | 0·24 | 0·27 | 0·40 |
| Chlorure de sodium ... | 0·03 | 0·03 | 0·06 | 0·03 | 0·03 | 0·04 | 0·04 | 0·08 | 0·12 | 0·05 | 0·07 | 0·13 |
| Carbonate ,, ... | traces | traces | 0·011 | légères traces | 0·021 | 0·031 | 0·00 | traces | traces | traces | 0·021 | traces |
| Bicarbonate ,, ... | 0·15 | 0·16 | 0·17 | 0·18 | 0·15 | 0·13 | 0·17 | 0·17 | 0·17 | 0·13 | 0·15 | 0·13 |
| *Analyse mécanique (Kopecky).* | | | | | | | | | | | | |
| > 2 mm. ... ... | 0·50 | 0·56 | 0·44 | 0·88 | 0·44 | 0·86 | 0·32 | 0·58 | 0·70 | 0·52 | 1·88 | 1·32 |
| > 1 mm. ... ... | 0·74 | 0·52 | 0·74 | 0·90 | 0·74 | 1·16 | 0·52 | 0·76 | 0·80 | 1·30 | 1·70 | 1·40 |
| > ½ mm. ... ... | 1·26 | 0·40 | 1·40 | 0·50 | 0·68 | 0·88 | 1·40 | 0·72 | 0·86 | 1·14 | 0·80 | 0·28 |
| > ¼ mm. ... ... | 2·68 | 1·24 | 1·62 | 2·70 | 3·74 | 2·48 | 1·96 | 1·64 | 1·28 | 2·02 | 2·40 | 2·80 |
| Gros sable ... ... | 5·18 | 2·72 | 4·20 | 4·98 | 5·60 | 5·38 | 4·20 | 3·70 | 3·64 | 4·90 | 6·80 | 5·80 |
| Sable moyen ... | 10·50 | 9·86 | 14·52 | 8·82 | 8·92 | 10·94 | 10·56 | 7·12 | 8·54 | 9·22 | 10·42 | 14·08 |
| Sable fin ... ... | 26·80 | 31·16 | 29·16 | 38·38 | 27·64 | 26·64 | 26·46 | 26·62 | 29·02 | 25·32 | 28·14 | 22·74 |
| Soluble ... ... | 0·10 | 0·16 | 0·14 | 0·14 | 0·16 | 0·22 | 0·22 | 0·22 | 0·38 | 0·24 | 0·27 | 0·40 |
| Argile et limon fin ... | 57·42 | 56·10 | 51·98 | 47·68 | 57·68 | 56·82 | 58·56 | 62·34 | 58·42 | 60·32 | 54·37 | 56·98 |
| | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

## TABLEAU I (SUITE).

BATA

| Eléments solubles pour cent terre sèche | 0 à 30 | 30 à 60 | 60 à 90 |
|---|---|---|---|
| Résidu sec ... ... ... | 0·22 | 0·10 | 0·10 |
| Chlorure de sodium ... ... ... | 0·06 | 0·04 | 0·04 |
| Carbonate de sodium ... ... | 0·00 | 0·00 | 0·00 |
| Bicarbonate de sodium ... ... | 0·16 | 0·16 | 0·14 |
| *Analyse mécanique* (*Kopecky*). | | | |
| > 2 mm. ... ... ... ... | — | — | — |
| > 1 mm. ... ... ... ... | 1·00 | 0.94 | 0·94 |
| > ½ mm. ... ... ... ... | 1·16 | 1·44 | 0·82 |
| > ¼ mm. ... ... ... ... | 3·52 | 2·04 | 2·24 |
| Gros sable ... ... ... ... | 5·68 | 4·42 | 4·00 |
| Sable moyen ... ... ... | 14·98 | 8·96 | 7·60 |
| Sable fin ... ... ... ... | 24·52 | 20·10 | 20·40 |
| Soluble ... ... ... ... | 0·22 | 0·10 | 0·10 |
| Argile et limon fin ... ... ... | 54·60 | 66·42 | 67·90 |
| | 100·00 | 100·00 | 100·00 |

## TABLEAU II.

*Analyse chimique.*

| | BATA | KAFR-SOLIMAN |
|---|---|---|
| Perte au feu ... ... ... ... ... | 5·66 | 5·84 |
| Insoluble et silice ... ... ... ... | 61·48 | 62·03 |
| Fer ($Fe_2 O_3$) ... ... ... ... ... | 9·26 | 9·06 |
| Alumine ($Al_2O_3$) ... ... ... ... | 16·74 | 15·93 |
| Manganèse ($MnO_2$) ... ... ... ... | 0·21 | 0·17 |
| Chaux (CaO) ... ... ... ... | 3·20 | 3·40 |
| Magnésie (MgO) ... ... ... ... | 0·90 | 1·92 |
| Potasse ($K_2O$) ... ... ... ... | 0·55 | 0·68 |
| Soude ($Na_2O$) ... ... ... ... | 0·36 | 0·38 |
| Acide phosphorique ($P_2O_5$) ... ... ... | 0·25 | 0·31 |
| Acide sulfurique ($SO_3$) ... ... ... ... | 0·08 | 0·07 |
| Acide carbonique ($CO_2$) ... ... ... | 0·90 | 0·75 |
| Azote ... ... ... ... ... ... | 0·095 | 0·073 |
| *Assimilable.* | | |
| Silice ($SiO_2$) ... ... ... ... ... | 0·334 | 0·334 |
| Potasse ($K_2O$) ... ... ... ... | 0·031 | 0·021 |
| Acide phosphorique ($P_2O_5$) ... ... ... | 0·025 | 0·024 |

*Analyse mécanique* (*Schloesing*).

| | | | BATA | KAFR-SOLIMAN |
|---|---|---|---|---|
| Terre fine | Eléments grossiers ... ... ... | | 0·000 | 0·000 |
| | Sable grossier | Calcaire ... ... ... | 9·000 | 5·000 |
| | | Siliceux ... ... ... | 106·000 | 106·000 |
| | | Non calcaire et non siliceux ... | 0·000 | 3·000 |
| | | Débris organiques ... ... | 2·000 | 1·000 |
| | Sable fin | Calcaire ... ... ... | 30·000 | 32·000 |
| | | Siliceux ... ... ... | 473·000 | 553·000 |
| | | Non calcaire et non siliceux ... | 0·000 | 66·000 |
| | Argile ... ... ... ... | | 352·000 | 228·000 |
| | Humus ... ... ... ... | | 28·000 | 6·000 |
| | | | 1,000·000 | 1,000·000 |

TABLEAU II (SUITE).

*Analyse mécanique* (*Beam*).

| | Bata | | | Kafr-Soliman |
|---|---|---|---|---|
| | 0 à 30 | 30 à 60 | 60 à 90 | 0 à 30 cm. |
| Sable grossier > ½ mm. ... ... | 2·28 | 2·54 | 2·30 | 1·12 |
| Sable fin et limon > tamis No. 100... | 37·14 | 29·46 | 31·12 | 48·80 |
| Limon fin > tamis No. 100 ... | 17·00 | 20·20 | 16·40 | 16·72 |
| Argile ... ... ... ... | 43·36 | 47·70 | 50·08 | 32·32 |
| Sels solubles ... ... ... | 0·22 | 0·10 | 0·10 | 1·04 |
| | 100·00 | 100·00 | 100·00 | 100·00 |

engrais employés dans tous ces essais et leurs doses respectives en kilos par feddan:—

| | |
|---|---|
| Sulfate d'ammoniaque ... ... ... | 100 kilos au fed. |
| Nitrate de soude ... ... ... | 100 ,, ,, |
| Scories Thomas ... .. ... | 200 ,, ,, |
| Sulfate de potasse ... ... ... | 100 ,, ,, |
| Fumier de ferme (engrais baladi) ... ... | 16 m.c. ,, |
| Superphosphate 16/18 ... ... ... | 200 kilos ,, |
| Cyanamide de chaux ... ... ... | 100 ,, ,, |

A part le nitrate de soude qui a été appliqué en poquet au pied des plantes au moment de l'éclaircissage, tous les autres engrais ont été enfouis au dernier labour de préparation. Les engrais ont été employés aux doses précitées suivant des formules indiqués aux tableaux ci-annexés, où chacune porte toujours le même numéro.

En 1912, comme en 1913, chaque engrais a été répété quatre fois, sauf les témoins qui l'ont été huit fois. On avait choisi 8 parcelles séparées, dont 4 à Bata et les 4 autres à Kafr-Soliman. Chacune des parcelles avait été divisée en douze lots de ⅛ de feddan à Bata et de $\frac{1}{12}$ à Kafr-Soliman. On s'était assuré de l'homogénéité du sol au point de vue de la texture, des sels, etc., par des sondages poussés jusqu'à 90 cm. de profondeur. (Voir Analyses, Tableaux I et II.)

Malgré ces précautions il y eut entre les diverses parcelles de légères différences qu'on n'avait pu soupçonner. Ce qui m'a conduit pour les essais de 1914 à répéter sur le même champ cinq fois la même formule avec répartition en chicane.

La distribution des engrais a été faite aussi uniformément que possible. Les parcelles ont reçu les mêmes traitements; elles avaient porté les mêmes cultures, avaient été fumées de la même manière et travaillées par les mêmes cultivateurs. Les billions ont été tracés avec un écartement de om.80 d'axe en axe. Les semis ont été faits autant que possible en quinconce (ce qui est difficile à obtenir) et à une distance de om.50 entre les poquets. On s'est attaché à avoir partout le même nombre de pieds. Cependant on éprouve d'assez grandes difficultés à observer cette dernière mesure, parce que le nombre de manquants diffère souvent sensiblement entre les différents lots. Il arrive que l'on soit obligé de réensemencer plus d'une fois. Or il est acquis que les plantes issues de réensemencements tardifs, produisent peu ou pas de coton. J'ai essayé, cette année, le repiquage au lieu du réensemencement. Les résultats n'en sont pas encore connus.

L'intensité des ravages du *Prodenia litura*, Fabr., a été appréciée en comptant le nombre des feuilles infestées. En 1912 et en 1913, ces ravages ont, du reste, été insignifiants. L'intensité des attaques des "Earias" et des "Gelechia" a été jugée d'après le nombre des capsules piquées. Pour les Gelechia en particulier, on a compté dans les différents lots de coton, le nombre de graines simples et doubles contenant des larves, ainsi que le nombre de graines vides. Sur quelques lignes enfin, on a relevé pour chaque formule la marche de la floraison et de la formation des capsules.

L'étude de l'influence des engrais sur ces phénomènes fera l'objet d'un travail ultérieur.

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Cela dit, examinons les résultats obtenus. Pour être bref, j'ai résumé dans une série de 10 tableaux toutes les données en y ajoutant tous les détails nécessaires.

1° *Action des engrais sur les rendements. (Voir Tableux III à V.)*

De l'examen des tableaux III à V, il appert qu'à Bata les engrais chimiques appliqués au cotonnier sont susceptibles de produire des excédents de rendement appréciables. Ces excédents sont dûs surtout à l'apport de

# TABLEAU III.

## ESSAIS FAITS A BATA (MENOUFIA).

*Résultats moyens des parcelles exprimés en kantars de 315 rotolis au feddan.*

| Nature des engrais | 1re cueillette | Erreur probable | 2me cueillette | Erreur probable | Total | Erreur probable | Excédent ou déficit en kantars au feddan | Erreur probable de la différence | 1re cueillette en pour cent de la récolte totale | Erreur probable | 2me cueillette en pour cent de la récolte totale | Erreur probable |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Année 1913.* | | | | | | | | | | | | |
| 1. Sulfate d'ammoniaque ... ... | 6·06 | 0·20 | 0·50 | 0·25 | 6·56 | 0·13 | +0·26 | 0·16 | 92 | 3 | 8 | 4 |
| 2. Nitrate de soude ... ... | 6·54 | 0·33 | 0·68 | 0·39 | 7·22 | 0·40 | +0·92 | 0·41 | 91 | 4 | 9 | 5 |
| 3. Scories + sulfate de potasse ... | 5·44 | 0·37 | 0·41 | 0·25 | 5·85 | 0·20 | −0·55 | 0·23 | 93 | +5, −6 | 7 | 4 |
| 4. Cyanamide de chaux ... ... | 6·11 | 0·37 | 0·60 | 0·33 | 6·71 | 0·34 | +0·41 | 0·35 | 91 | 5 | 9 | 5 |
| 5. Scories Thomas ... ... | 5·65 | 0·58 | 0·32 | 0·16 | 5·97 | 0·47 | −0·33 | 0·48 | 95 | +4, −10 | 5 | 2 |
| 6. Témoin (sans engrais) ... ... | 5·90 | 0·33 | 0·53 | 0·26 | 6·43 | 0·09 | — | — | 92 | 5 | 8 | 4 |
| 7. Sulfate de potasse ... ... | 5·44 | 0·36 | 0·38 | 0·20 | 5·82 | 0·17 | −0·48 | 0·20 | 93 | +5, −6 | 7 | 4 |
| 8. Témoin (sans engrais) ... ... | 5·79 | 0·24 | 0·37 | 0·22 | 6·16 | 0·10 | — | — | 94 | 4 | 6 | 4 |
| 9. Nitrate de soude + scories ... | 6·63 | 0·22 | 0·42 | 0·20 | 7·05 | 0·10 | +0·75 | 0·14 | 94 | 3 | 6 | 3 |
| 10. *Complet :* nitrate + sulfate de potasse + scories | 6·93 | 0·40 | 0·48 | 0·22 | 7·41 | 0·24 | +1·11 | 0·26 | 94 | +4, −5 | 6 | 3 |
| 11. Nitrate + sulfate de potasse ... | 5·94 | 0·52 | 0·47 | 0·22 | 6·41 | 0·40 | +0·11 | 0·41 | 93 | +5, −8 | 7 | 3 |
| 12. Engrais baladi (fumier) ... ... | 5·65 | 0·52 | 0·35 | 0·19 | 6·00 | 0·27 | −0·30 | 0·29 | 94 | +4, −8 | 6 | 3 |
| *Année 1912.* | | | | | | | | | | | | |
| 1. Nitrate de soude ... ... | 4·08 | 0·47 | 2·40 | 0·44 | 6·48 | 0·98 | +1·47 | 1·08 | 63 | 8 | 37 | 7 |
| 2. Témoin (sans engrais) ... ... | 3·60 | 0·38 | 1·41 | 0·14 | 5·01 | 0·46 | — | — | 72 | 8 | 28 | 3 |
| 3. *Complet :* nitrate + sulfate de potasse + scories | 4·03 | 0·58 | 2·30 | 0·16 | 6·33 | 0·74 | +1·32 | 0·87 | 64 | 9 | 36 | 2 |
| 4. Nitrate + sulfate de potasse .. | 4·67 | 0·49 | 2·47 | 0·36 | 7·14 | 0·29 | +2·13 | 0·54 | 65 | 7 | 35 | 5 |
| 5. Engrais baladi (fumier) ... ... | 4·87 | 0·46 | 1·89 | 0·60 | 6·76 | 0·70 | +1·75 | 0·84 | 72 | 7 | 28 | 9 |
| 6. Nitrate + superphosphate ... | 4·53 | 0·32 | 2·30 | 0·52 | 6·83 | 0·58 | +1·82 | 0·74 | 66 | 4 | 34 | 8 |
| 7. Sulfate de potasse + superphosphate | 4·83 | 0·44 | 1·58 | 0·41 | 6·41 | 0·68 | +1·40 | 0·82 | 75 | 7 | 25 | 7 |

TABLEAU III (SUITE).

*Année* 1911.

| Nature des engrais | 1re cueillette | 2me cueillette | 3me cueillette | Total | Excédent ou déficit | 1re cueillette pour cent | 2me cueillette pour cent | 3me cueillette pour cent |
|---|---|---|---|---|---|---|---|---|
| 1. Nitrate en deux fois ... | 2·41 | 2·65 | 0·49 | 5·55 | +0·61 | 43 | 48 | 9 |
| 2. Nitrate en une fois ... | 2·31 | 2·49 | 0·36 | 5·16 | +0·22 | 45 | 48 | 7 |
| 3. Témoin (sans engrais) ... | 2·86 | 1·89 | 0·36 | 5·11 | — | 56 | 37 | 7 |
| 4. Témoin (sans engrais) ... | 2·15 | 2·41 | 0·47 | 5·03 | — | 43 | 48 | 9 |
| 5. Nitrate + superphosphate | 2·07 | 2·49 | 0·39 | 4·95 | +0·01 | 42 | 50 | 8 |
| 6. Superphosphate (avant) | 2·12 | 1·97 | 0·49 | 4·58 | −0·36 | 46 | 43 | 11 |
| 7. Superphosphate (après) | 2·42 | 1·99 | 0·39 | 4·80 | −0·14 | 50 | 42 | 8 |
| 8. Témoin (sans engrais) ... | 2·62 | 1·79 | 0·28 | 4·69 | — | 56 | 38 | 6 |

l'élément azoté dont l'utilité par cette localité se confirme du reste par des essais antérieurs poursuivis depuis 1903.

L'azote sous forme d'azote nitrique directement assimilable appliqué en poquet, de bonne heure, en une où en deux fois (voir résultats 1911) paraît être le plus efficace. Cependant cette efficacité varie dans d'assez larges limites, suivant les années (comparer entre elles les années 1911, 1912 et 1913).

Les engrais phosphatés, employés seuls, soit sous forme de scories (1913), soit sous forme de super (1912), ont donné des résultants plutôt négatifs. Associés au nitrate ils donnent de bons résultats. Bien que l'excédent obtenu ne compense pas toujours les frais occasionnés par l'application des engrais phosphatés, il semble néanmoins que ces derniers exercent une certaine action favorable en ce que, associés aux engrais azotés, ils corrigent leur tendance à retarder quelque peu la maturité, surtout dans le nord, comme nous allons le dire.

Le super paraît être plus favorable sous ce rapport que les scories, toutefois ces deux engrais n'ont pas été essayés concurrement et dans la même année et l'on ne peut dès lors se prononcer définitivement à leur égard.

La potasse seule n'a produit aucune augmentation de rendement. Associée au nitrate, elle n'a pas eu d'effet utile en 1913; tandis qu'en 1912, elle a augmenté sensiblement la récolte.

Le fumier de ferme, appliqué directement au coton, a produit de mauvais effets en 1913; tandis qu'en 1912 la

## TABLEAU IV.

ESSAIS FAITS A KAFR-SOLIMAN (GHARBIA).

*Résultats moyens exprimés en kantars de 315 rotolis au feddan.*

*Année* 1913.

| Nature des engrais | 1re cueillette | Erreur probable | 2me cueillette | Erreur probable | Total | Récolte entière — Excédent ou déficit | Erreur probable de la différence | 1re cueillette pour cent | Erreur probable | 2me cueillette pour cent | Erreur probable |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Sulfate d'ammoniaque ... | 5·47 | 0·31 | 0·77 | 0·05 | 6·24 | +0·04 | 0·37 | 88 | 5 | 12 | 1 |
| 2. Nitrate de soude ... ... | 5·83 | 0·46 | 1·05 | 0·20 | 6·88 | +0 68 | 0·37 | 85 | 7 | 15 | 3 |
| 3. Scories + sulfate de potasse ... | 5·85 | 0·16 | 1·09 | 0·16 | 6·94 | +0·74 | 0·23 | 84 | 2 | 16 | 2 |
| 4. Cyanamide de chaux ... ... | 4·95 | 0·35 | 1·09 | 0·16 | 6·04 | −0·16 | 0·36 | 82 | 6 | 18 | 3 |
| 5. Scories Thomas ... ... | 5·14 | 0·20 | 0·74 | 0·05 | 5·88 | −0·32 | 0·23 | 87 | 4 | 13 | 1 |
| 6. Témoin (sans engrais) ... | 4·69 | 0·14 | 0·84 | 0·17 | 5·53 | — | — | 85 | 2 | 15 | 3 |
| 7. Sulfate de potasse ... ... | 5·58 | 0·28 | 1·13 | 0·12 | 6·71 | +0·51 | 0·36 | 83 | 4 | 17 | 2 |
| 8. Témoin (sans engrais) ... | 5·78 | 0·14 | 1·10 | 0·12 | 6·88 | — | — | 84 | 2 | 16 | 2 |
| 9. Nitrate + scories ... ... | 5·76 | 0·79 | 0·85 | 0·19 | 6·61 | +0·41 | 0·72 | 87 | 8 | 13 | 3 |
| 10. *Complet* : nitrate + sulfate de potasse + scories | 5·76 | 0·55 | 1·08 | 0·11 | 6·84 | +0·64 | 0·50 | 84 | 8 | 16 | 2 |
| 11. Nitrate + sulfate de potasse ... | 5·51 | 0·53 | 1·16 | 0·08 | 6·67 | +0·47 | 0·57 | 83 | 8 | 17 | 1 |
| 12. Engrais baladi (fumier) ... | 4·49 | 0·15 | 0·98 | 0·17 | 5·47 | −0·73 | 0·29 | 82 | 3 | 18 | 3 |

## TABLEAU V.

CUEILLETTES COMPARÉES À CELLES DES TÉMOINS.

*Résultats moyens exprimés en kantars de* 315 *rotolis au feddan.*

*Année* 1913.

| Nature des engrais | Bata (Menoufia) | | Kafr-Soliman (Gharbia) | |
|---|---|---|---|---|
| | 1re cueillette | 2me cueillette | 1re cueillette | 2me cueillette |
| 1. Sulfate d'ammoniaque ... ... | +0·22 | +0·05 | +0·23 | −0·20 |
| 2. Nitrate de soude ... ... | +0·70 | +0·23 | +0·59 | +0·08 |
| 3. Scories + sulfate de potasse ... | −0·40 | −0·04 | +0·61 | +0·12 |
| 4. Cyanamide de chaux ... ... | +0·27 | +0·15 | −0·29 | +0·12 |
| 5. Scories Thomas ... ... | −0·19 | −0·13 | −0·10 | −0·23 |
| 6. Témoin (sans engrais) ... ... | — | — | — | — |
| 7. Sulfate de potasse ... ... | −0·40 | −0·07 | +0·34 | +0·16 |
| 8. Témoin (sans engrais) ... ... | — | — | — | — |
| 9. Nitrate de soude + scories ... | +0·79 | −0·03 | +0·52 | −0·12 |
| 10. *Complet :* nitrate + sulfate de potasse + scories | +1·09 | +0·03 | +0·52 | +0·11 |
| 11. Nitrate + sulfate de potasse ... | +0·10 | +0·02 | +0·27 | +0·19 |
| 12. Engrais baladi (fumier) ... | −0·19 | −0·10 | −0·75 | +0·01 |

récolte en a beaucoup profité. En général son action est assez favorable.

Les résultats obtenus à Kafr-Soliman montrent que dans cette localité les engrais chimiques de même que le fumier de ferme appliqués directement au cotonnier exercent sur le rendement une influence peu sensible. Les résultats sont de même ordre que ceux de Bata, quant au nitrate. Ils en diffèrent en ce qui regarde l'action de la cyanamide, des scories seules ou associées au sulfate de potasse, et enfin de ce dernier engrais.

Toutefois l'engrais complet n'a pas donné ici de bons résultats.

En 1913, le fumier de ferme ou engrais baladi, a Kafr-Soliman comme à Bata, s'est montré inférieur aux engrais chimiques.

Il semble dès lors que l'année 1913 lui a été défavorable.

Dans les deux localités, c'est surtout la première cueillette, dans le cas de deux cueillettes; la première et la deuxième dans le cas de trois cueillettes, qui semblent influencées par les engrais; la dernière cueillete semble dépendre d'autres facteurs (climat, etc). Cependant, une première cueillette abondante n'est pas nécessairement suivie d'une deuxième peu élevée; il y a tendance même à ce que l'inverse ait lieu.

Je n'insisterai pas davantage sur les résultats de ces deux premières années, quant aux rendements culturaux.

### 2° *Action des engrais sur la maturité.*

Ce point mérite notre attention. Il est important, en effet, de ne rien négliger des facteurs qui peuvent hâter la maturité, surtout dans le nord de l'egypte (à cause des brouillards, insectes, etc.).

Nos essais de Bata et de Kafr-Soliman accusent peu de relation entre les engrais et la maturité de la récolte. Toutefois, en suivant les dates d'apparition des capsules et en comptant dans les différents carrés, celles qui restent sur les plantes après la dernière cueillette sans jamais s'ouvrir, on s'aperçoit de la légère tendance qu'ont les engrais azotés même dans ces régions à retarder quelque peu la maturité.

Des expériences poursuivies depuis 1908 aux environs de Belcas ont fait mieux ressortir cette tendance. Aussi, l'excédent qu'on y obtient par l'emploi du nitrate varie considérablement suivant les conditions climatériques de l'arrière-saison.

A cet égard, l'emploi des engrais phosphatés associés aux engrais azotés est avantageux dans ces parties où la durée de la végétation est relativement courte. Le super serait plus efficace que les scories.

Dans le sud et le centre (Bata et Kafr-Soliman) cette heureuse influence des engrais phosphatés n'apparaît pas bien nettement, et les résultats obtenus en 1911, 1912 et 1913 mettent en évidence l'intervention dans la maturité d'autres agents plus puissants que les engrais.

### 3° *Action des engrais sur le rendement à l'égrenage et le Lint-index.* (*Voir Tableau VI.*)

On peut dire que tous les engrais qui produisent un excédent de récolte diminuent ce rendement, et que cette

## TABLEAU VI.

### Influence des Engrais sur le Poids des Graines, le Rendement à l'Égrenage et le "Lint-Index."

*Résultats moyens.*

*Bata* (*Menoufia*), 1913.

| Nature des engrais | Poids de 100 graines nues en grammes | | | | Rendement à l'égrenage | | | | Rendement industriel | | | | Lint index | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | |
| | Poids | Erreur probable de la différence | Poids | Erreur probable de la différence | Pour cent | Erreur probable de la différence | Pour cent | Erreur probable de la différence | Pour cent | Erreur probable de la différence | Pour cent | Erreur probable de la différence | Index | Erreur probable de la différence | Index | Erreur probable de la différence |
| 1. Sulfate d'ammoniaque ... | 11·3 | 0·16 | 9·9 | 0·23 | 33·9 | 0·17 | 32·0 | 0·52 | 106·8 | 0·54 | 100·8 | 1·64 | 5·83 | 0·06 | 4·65 | 0·17 |
| 2. Nitrate de soude ... | 11·5 | 0·21 | 10·1 | 0·27 | 33·0 | 0·40 | 32·6 | 0·27 | 103·9 | 1·30 | 102·6 | 0·85 | 5·65 | 0·11 | 4·87 | 0·13 |
| 3. Scories + sulfate de potasse | 11·1 | 0·21 | 9·8 | 0·22 | 33·6 | 0·33 | 32·7 | 0·34 | 105·8 | 1·09 | 102·9 | 1·11 | 5·59 | 0·07 | 4·77 | 0·14 |
| 4. Cyanamide de chaux ... | 11·1 | 0·16 | 10·0 | 0·23 | 33·7 | 0·17 | 32·3 | 0·46 | 106 8 | 0·54 | 101·8 | 1·45 | 5·61 | 0·05 | 4·75 | 0·13 |
| 5. Scories Thomas ... | 10·7 | 0·21 | 9·8 | 0·32 | 34·2 | 0·17 | 32·5 | 0·52 | 107·6 | 0·90 | 102·4 | 1·64 | 5 55 | 0·17 | 4·69 | 0·18 |
| 6. Témoin (sans engrais) ... | 10·7 | — | 9·6 | — | 34·4 | — | 33·1 | — | 108·4 | — | 104·2 | — | 5 61 | — | 4·75 | — |
| 7. Sulfate de potasse ... | 10·8 | 0·16 | 9·9 | 0·23 | 34·2 | 0·22 | 33·5 | 0·40 | 107·9 | 0·66 | 105·5 | 1·27 | 5·65 | 0·05 | 4·98 | 0·16 |
| 8. Témoin (sans engrais) ... | 10·9 | — | 9·8 | — | 34·6 | — | 32·9 | — | 108·9 | — | 103·7 | — | 5·77 | — | 4·80 | — |
| 9. Nitrate + scories ... | 11·3 | 0·16 | 9·8 | 0·27 | 33·5 | 0·15 | 32·2 | 0·52 | 105·5 | 0·49 | 101·6 | 1·64 | 5·73 | 0·06 | 4·67 | 0·13 |
| 10. *Complet*: nitrate + sulfate de potasse + scories | 11·5 | 0·21 | 10·0 | 0·23 | 33·7 | 0·40 | 32·3 | 0·34 | 106·0 | 1·30 | 101·8 | 1·11 | 5·84 | 0·06 | 4·75 | 0·14 |
| 11. Nitrate + sulfate de potasse | 11·2 | 0·21 | 10·0 | 0·23 | 33·9 | 0·69 | 32·0 | 0·52 | 106·8 | 2·16 | 100·8 | 1·64 | 5·73 | 0·12 | 4·76 | 0·16 |
| 12. Engrais baladi (fumier) ... | 11·1 | 0·16 | 10·0 | 0·23 | 33·8 | 0·33 | 32·6 | 0·27 | 106·6 | 1·09 | 102·6 | 0·85 | 5·70 | 0·08 | 4 82 | 0·12 |
| *Kafr-Soliman* (*Gharbia*), 1913. | | | | | | | | | | | | | | | | |
| 1. Sulfate d'ammoniaque ... | 11·4 | 0·40 | 9·4 | 0·25 | 31·8 | 0·51 | 30·5 | 1·30 | 100·0 | 1·64 | 96·0 | 3·43 | 5·28 | 0·18 | 4·12 | 0·33 |
| 2. Nitrate de soude ... | 11·5 | 0·21 | 9·8 | 0·25 | 32·7 | 0·51 | 30·2 | 1·47 | 102·9 | 1·64 | 95·2 | 4·01 | 5·59 | 0·13 | 4·22 | 0·37 |
| 3. Scories + sulfate de potasse | 11·5 | 0·27 | 10·0 | 0·11 | 33·1 | 0·56 | 30·8 | 1·36 | 104·1 | 1·79 | 96·8 | 3·62 | 5·74 | 0·12 | 4·44 | 0·31 |
| 4. Cyanamide de chaux ... | 11·7 | 0·27 | 10·1 | 0·25 | 32·9 | 0·51 | 31·9 | 1·16 | 103·7 | 1 61 | 100·4 | 2·84 | 5·74 | 0·22 | 4·72 | 0·35 |
| 5. Scories Thomas ... | 11·8 | 0·21 | 9·4 | 0·19 | 32·4 | 0·79 | 30·0 | 1·30 | 102·1 | 2·48 | 94·5 | 3·43 | 5·64 | 0·16 | 4·00 | 0·35 |
| 6. Témoin (sans engrais) ... | 11·5 | — | 10·0 | — | 32·9 | — | 31·4 | — | 103·5 | — | 98·8 | — | 5 62 | — | 4·54 | — |
| 7. Sulfate de potasse ... | 11·7 | 0·21 | 9·8 | 0·13 | 32·6 | 0·56 | 31·3 | 1·04 | 102·7 | 1·79 | 98·6 | 2·38 | 5·61 | 0·16 | 4·46 | 0·26 |
| 8. Témoin (sans engrais) ... | 11·3 | — | 10·8 | — | 31·9 | — | 31·6 | — | 100 4 | — | 99·4 | — | 5·24 | — | 4·58 | — |
| 9. Nitrate + scories ... | 11·4 | 0·27 | 9·8 | 0·25 | 31·8 | 0 61 | 30·4 | 1·52 | 100·0 | 1·94 | 95·8 | 4·21 | 5·32 | 0·25 | 4·28 | 0·42 |
| 10. *Complet*: nitrate + sulfate de potasse + scories | 11·6 | 0·27 | 9·8 | 0·19 | 32·3 | 0·67 | 30·6 | 0·99 | 101·7 | 1·82 | 96·4 | 2·15 | 5·52 | 0·18 | 4·24 | 0·29 |
| 11. Nitrate + sulfate de potasse | 11·5 | 0·40 | 10·3 | 0·13 | 32·3 | 0·67 | 30·9 | 1·25 | 101·7 | 1·82 | 97·4 | 3·25 | 5·47 | 0·24 | 4·62 | 0·53 |
| 12. Engrais baladi (fumier) ... | 11·7 | 0·27 | 9·9 | 0·13 | 32·8 | 0·61 | 31·0 | 1·08 | 103·3 | 1·94 | 97·6 | 2·52 | 5·66 | 0·14 | 4·43 | 0·31 |

diminution est d'autant plus sensible que l'efficacité de l'engrais est plus certaine et l'excédent plus grand.

Si nous examinons les poids de cent graines nous voyons tout de suite que l'excédent de récolte est accompagné d'une augmentation du poids de la graine.

Ainsi, les engrais et spécialement les engrais azotés qui augmentent la récolte augmentent proportionellement plus ce poids que celui de la fibre:[3] cependant il est évident que la diminution dans le rendement à l'égrenage n'est rien en comparaison avec l'excédent produit dans le poids total de la récolte.

L'examen des chiffres relatifs au "Lint-index";[4] confirme ce que je viens d'énoncer, et met en relief l'influence de l'association des engrais phosphatés aux engrais azotés. Les premiers engrais corrigent l'action des seconds et en définitive les fibres et les graines se trouvent bien d'une telle association. L'engrais complet donne également de très bons résultats à cet égard.

A la dernière cueillette, les différences entre les diverses formules s'atténuent beaucoup et parfois le classement est complètement changé. Ce qui tend à démontrer qu'ici également, il faut compter avec les conditions climatériques, les attaques d'insectes, etc.

4° *Action des engrais sur la susceptibilité aux attaques du "Ver Rose"* Gelechia gossypiella. (*Voir Tableaux VII et VIII.*)

A Bata nous voyons pour les graines doubles qu'à la *première cueillette*, la différence entre les diverses formules et les temoins n'excède point deux fois l'erreur probable de cette différence.

A la *deuxième cueillette*, cet écart est encore plus petit. Toute deduction à tirer des chiffres trouvés est donc incertaine.

On pourrait craindre que les engrais qui retardent la maturité n'exposent les dernières capsules aux attaques

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[3] M. Hughes était déjà arrivé à une conclusion analogue: "Manurial Trials on Cotton," *Year-book of the Khedivial Agricultural Society*, 1909.

[4] Poids de coton produit par cent graines.

## TABLEAU VII.

### Influence des Engrais sur les Attaques du Gelechia gossypiella.

*Résultats moyens.*

| Année 1913 | Bata (Menoufia), 1913 | | | | | | | | Kafr-Soliman (Gharbia), 1913 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Nombre de graines doubles dans un kilog. de graines | | | | Nombre de graines attaquées par mille graines | | | | Nombre de graines doubles dans un kilog. de graines | | | | Nombre de graines attaquées par mille graines | | | |
| Natures engrais | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | |
| | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence | Moyenne des parcelles | Erreur probable de la différence |
| 1. Sulfate d'ammoniaque ... | 26 | 7·5 | 235 | 48 | 4·0 | 2·8 | 51·6 | 10·3 | 41 | 11·6 | 560 | 39 | 12 | 7·2 | 87 | 17 |
| 2. Nitrate de soude ... ... | 15 | 8·6 | 249 | 30 | 5·3 | 3·9 | 42·4 | 8·8 | 36 | 9·4 | 572 | 63 | 10 | 6·4 | 97 | 17 |
| 3. Scories + sulfate de potasse ... | 11 | 7·0 | 225 | 42 | 6·6 | 5·2 | 53·2 | 12·0 | 30 | 12·8 | 484 | 35 | 10 | 7·4 | 88 | 15 |
| 4. Cyanamide de chaux ... ... | 16 | 7·5 | 252 | 37 | 4·0 | 2·8 | 52·0 | 9·5 | 24 | 9·0 | 435 | 33 | 8 | 6·2 | 71 | 14 |
| 5. Scories Thomas ... ... | 13 | 7·0 | 177 | 34 | 4·0 | 1·2 | 27·6 | 7·6 | 36 | 10·2 | 518 | 40 | 12 | 7·4 | 92 | 19 |
| 6. Témoin (sans engrais)... ... | 13 | — | 199 | — | 0 | — | 41·0 | — | 28 | — | 542 | — | 9 | — | 93 | — |
| 7. Sulfate de potasse ... ... | 7 | 5·5 | 187 | 31 | 6·7 | 4·0 | 37·2 | 14·4 | 38 | 10·7 | 493 | 52 | 9 | 6·0 | 85 | 16 |
| 8. Témoin (sans engrais)... ... | 7 | — | 165 | — | 4·0 | — | 18·7 | — | 38 | — | 497 | — | 12 | — | 85 | — |
| 9. Nitrate + scories ... ... | 16 | 7·5 | 223 | 33 | 4·0 | 2·8 | 57·3 | 9·7 | 47 | 15·8 | 536 | 87 | 16 | 5·4 | 77 | 16 |
| 10. *Complet :* nitrate + sulfate de potasse + scories | 21 | 6·1 | 227 | 40 | 8·0 | 2·8 | 38·4 | 9·8 | 40 | 9·7 | 638 | 36 | 18 | 5·6 | 109 | 15 |
| 11. Nitrate + sulfate de potasse ... | 11 | 7·0 | 209 | 36 | 5·3 | 1·9 | 32·8 | 10·7 | 34 | 9·7 | 588 | 68 | 12 | 5·2 | 92 | 18 |
| 12. Engrais baladi (fumier) ... | 15 | 7·5 | 186 | 41 | 4·0 | 2·8 | 36·0 | 9·6 | 31 | 11·1 | 545 | 28 | 9 | 7·8 | 81 | 14 |

TABLEAU VIII.

INFLUENCE DES ENGRAIS SUR LES ATTAQUES DU GELECHIA GOSSYPIELLA.

*Résultats moyens comparés à ceux des témoins près pair* 100.

| Nature des engrais | Nombre de graines attaquées sur 1,000 graines | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Bata (Menoufia), 1913 | | | | Kafr-Soliman (Gharbia), 1913 | | | |
| | 1re cueillette | | 2me cueillette | | 1re cueillette | | 2me cueillette | |
| | Moyenne | Erreur probable de la différence | Moyenne | Erreur probable de la différence | Moyenne | Erreur probable de la différence | Moyenne | Erreur probable de la différence |
| Sulfate d'ammoniaque | 260 | 74 | 129 | 26 | 124 | 35 | 108 | 7 |
| Nitrate de soude ... | 150 | 86 | 137 | 16 | 109 | 27 | 110 | 12 |
| Scories + sulfate de potasse | 110 | 70 | 124 | 23 | 91 | 38 | 93 | 6 |
| Cyanamide de chaux... | 160 | 74 | 138 | 20 | 73 | 26 | 84 | 6 |
| Scories Thomas .. | 130 | 70 | 97 | 18 | 109 | 29 | 100 | 7 |
| Témoin (sans engrais) | 100 | — | 100 | — | 100 | — | 100 | — |
| Sulfate de potasse ... | 70 | 55 | 103 | 16 | 115 | 31 | 95 | 10 |
| Témoin (sans engrais) | 100 | — | 100 | — | 100 | — | 100 | — |
| Nitrate + scories ... | 160 | 74 | 123 | 17 | 143 | 47 | 103 | 16 |
| *Complet :* nitrate + sulfate de potasse + scories | 210 | 61 | 125 | 21 | 121 | 29 | 123 | 6 |
| Nitrate + sulfate de potasse | 110 | 70 | 115 | 19 | 103 | 29 | 113 | 14 |
| Engrais baladi (fumier) | 150 | 74 | 102 | 22 | 94 | 33 | 105 | 5 |

des insectes. Il semble résulter cependant d'expériences faites à Belcas et à Mit Salsil dans le Nord du Delta, qu'il n'y ait pas de relation entre les engrais et le nombre de graines attaquées.

L'examen des chiffres relatifs à Kafr-Soliman montre d'une part qu'il y a une différence notable entre Bata et cette localité quant à l'intensité des attaques, et ensuite que les données sont sujettes à des erreurs telles, qu'il est impossible de conclure en toute certitude. D'autre part, à Belcas et à Mit Salsil, il y a eu moins de graines attaquées qu'à Kafr-Soliman, bien que les deux premières localités soient plus au nord. Du reste si l'on considère le nombre de graines *attaquées* sur mille et que l'on se reporte au tableau des résultats comparés au témoin pris pour cent, on constate tant à Bata qu'à Kafr-Soliman que les différentes engrais ne doivent pas jouer un rôle important dans la question des attaques du ver rose. Ce sont sans doute des agents climatériques et autres qui en réglant les conditions de l'existence et de la multiplication de l'insecte, règlent en même temps l'intensité de ses ravages.

La corrélation établie entre la 1re et la 2me cueillette donne pour Bata $r = + 0{\cdot}60 \pm 0{\cdot}18$ et pour Kafr-Soliman $r = + 0{\cdot}45 \pm 0{\cdot}17$. Dans les 2 cas la corrélation est positive et égale ou supérieure à 3 fois l'erreur probable; ce qui signifie qu'il y a une relation effective entre le nombre de graines doubles de la 1re cueillette et celui des mêmes graines de la 2me cueillette, avec des chances de 21 contre 1. Il est intéressant de noter que dans les deux localités, la 2me cueillette a tendance a contenir en moyenne environ 15 fois plus de graines doubles que la première. Mais il ne faut pas attacher une trop grande valeur à cette déduction tirée d'une seule année d'observation.

### 5° *Action des engrais sur les qualités des fibres.*

J'ai voulu profiter des expériences de 1912 et 1913, pour étudier cette très importante question. Une tentative de ce genre avait été faite en 1902; mais l'examen n'avait porté que sur un nombre d'échantillons trop restreint.[5]

Cinquante six lots de coton provenant des diverses parcelles, ont été envoyés à l'Imperial Institute de Londres, aux fins d'analyse et d'évaluation commerciale.

Les résultats ont été condensés dans les tableaux ci-annexés.

C'est la première fois, à ma connaissance, que l'on a apporté dans un examen de ce genre, un aussi haut degré de garantie et de précision. Les cotons examinés proviennent tous, de la 1re cueillette.

(*a*) *Couleur et brillant* (voir Tableau IX).—Tous les cotons possédaient en commun un léger défaut d'homogénéité dans la couleur, sans qu'on puisse assigner à l'un d'entre eux une infériorité manifeste à cet égard.

D'un autre côté, l'intensité de la coloration pour chaque

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[5] Henry Yves.—*Journal d'Agriculture pratique des Pays chauds*, 1902.

*Bata*, 1913.

| Nature des engrais | Brillant | | | Couleur | | |
|---|---|---|---|---|---|---|
| | Parcelle 1 | Parcelle 2 | Parcelle 3 | Parcelle 1 | Parcelle 2 | Parcelle 3 |
| 1. Sulfate d'ammoniaque | Assez brillant ... | Assez brillant ... | Assez bien brillant | Irrégulière ... ... | Irrégulière ... ... | Légèrement irrégulière |
| 2. Nitrate de soude ... | ,, ... | Brillant ... | Modérément ... | ,, ... ... | ,, ... ... | ,, ,, |
| 3. Scories + sulfate potasse | Assez bien brillant | ,, ... | Assez bien brillant | ,, ... ... | ,, ... ... | Trés légèrement irrégulière |
| 4. Cyanamide de chaux ... | Modérément ... | ,, ... | Modérément ... | ,, ... ... | Légèrement irrégulière | Légerèment irrégulière |
| 5. Scories ... ... | ,, ... | ,, ... | ,, ... | ,, ... ... | ,, ,, | ,, ,, |
| 6. Témoin (sans engrais) | Brillant ... | ,, ... | Brillant ... | ,, ... ... | Irrégulière ... ... | Irrégulière |
| 7. Sulfate de potasse ... | Assez brillant ... | Modérément ... | Assez brillant ... | Légèrement irrégulière | Légèrement irrégulière | ,, |
| 9. Nitrate + scories ... | ,, ... | Assez brillant ... | ,, ... | ,, ,, | ,, ,, | Légèrement irrégulière |
| 10. *Complet:* nitrate + scories + sulfate de potasse | ,, ... | ,, ... | ,, ... | ,, ,, | ,, ,, | Irrégulière |
| 11. Nitrate + sulfate potasse | Modérément ... | Assez bien brillant | ,, ... | ,, ,, | ,, ,, | Légèrement irrégulière |
| 12. Baladi (fumier) ... | Assez brillant ... | Assez brillant ... | Modérément ... | ,, ,, | ,, ,, | ,, ,, |
| | *Kafr-Soliman*, 1913. | | | | | |
| 2. Nitrate de soude ... | Brillant ... | Brillant ... | Assez brillant ... | Irrégulière ... ... | Légèrement irrégulaire | — |
| 6. Témoin (sans engrais) | ,, ... | ,, ... | ,, ... | Légèrement irrégulière | — | Légèrement irrégulière |
| 9. Nitrate + scories ... | ,, ... | ,, ... | Brillant ... | ,, ,, | Légèrement irrégulaire | ,, ,, |
| 10. *Complet:* nitrate + scories + sulfate de potasse | Assez brillant ... | ,, ... | ,, ... | ,, ,, | ,, ,, | ,, ,, |
| 11. Nitrate + sulfate potasse | Brillant ... | Assez brillant ... | Assez brillant ... | — | ,, ,, | ,, ,, |
| 12. Baladi (fumier) ... | Assez brillant ... | Brillant ... | Brillant ... | — | ,, ,, | ,, ,, |
| | *Bata*, 1912. | | | | | |
| 2. Nitrate de soude ... | Assez brillant ... | — | — | Légèrement irrégulière | — | — |
| 9. Nitrate + superphosphate | ,, ... | — | — | ,, ,, | — | — |
| 10. *Complet:* nitrate + superphosphate + sulfate de potasse | Brillant ... | — | — | Irrégulière ... ... | — | — |
| 11. Nitrate + sulfate potasse | Assez brillant ... | — | — | Légèrement irrégulière | — | — |
| 12. Baladi (fumier) ... | ,, ... | — | — | ,, ,, | — | — |

variété considérée à part, a été, à peu de chose près, la même pour tous les lots.

Les variations ont été à peine sensibles et tantôt à l'avantage, tantôt en défaveur de la même formule. Le diamètre, du moins pour le Jannovitch, le Nubari et l'Assili, n'augmente pas avec l'intensité de la coloration, ainsi que l'avait signalé M. Yves Henry pour l'Abassi.

Au point de vue du brillant, les cotons de même variété mais de diverses formules, ne se distinguent presque pas les uns des autres.

Si, en effet, la cyanamide de chaux paraît avoir à Bata une certaine tendance à atténuer le brillant, on ne lui retrouve pas ce défaut à Kafr-Soliman, où il s'agit pourtant d'un coton plus délicat : le Jannovitch,

(*b*) *Maturité* (voir Tableau X).—De tous les états de la fibre la maturité est celui qui influe le plus sur ses qualités et particulièrement sur sa résistance.

Les lots dont les fibres étaient les plus résistantes contenaient le moins de coton mort ou non encore arrivé à maturité. Cette maturité doit être sans doute considérablement influencée par des conditions climatériques ou autres, puisque nous voyons que la même formule appliquée dans la même localité produit suivant les années des résultats differents. Des conditions locales doivent également intervenir. Toutefois la maturité paraît avoir été favorisée par l'emploi des engrais azotés associés aux engrais phosphatés avec ou sans potasse.

(*c*) *Résistance* (voir Tableau X).—On constate un léger défaut d'homogénéité qui varie plus suivant les parcelles que suivant les engrais. Aucun de ces derniers ne semble exercer sur l'homogénéité de résistance une action visiblement défavorable.

Les fibres des Nos. 9 (scories + nitrate) et 10 (complet) sont les plus résistantes parmi les Nubari de Bata. A Kafr-Soliman, la formule 11 (nitrate + sulfate de potasse) a été supérieure aux autres.

D'une manière générale et nonobstant l'influence manifeste du sol, des arrosages, etc., on peut dire que les engrais améliorent plutôt la résistance des fibres et que c'est l'engrais complet qui est le meilleur.

(*d*) *Longueur des fibres* (voir Tableaux XI et XII).—

## TABLEAU X.

### INFLUENCE DES ENGRAIS SUR LES QUALITÉS DE LA FIBRE.*

*Résultats détaillés.*

| Nature des engrais | Résistance | | | Quantité de coton mort (Non arrivé à maturité) | | |
|---|---|---|---|---|---|---|
| | Parcelle 1 | Parcelle 2 | Parcelle 3 | Parcelle 1 | Parcelle 2 | Parcelle 3 |
| *Bata* 1913 (*Nubari*). | | | | | | |
| 1. Sulfate d'ammoniaque ... ... ... | Bonne | Assez bonne | Moyenne | Moyenne | Modérée | Grande |
| 2. Nitrate de soude ... ... ... | Moyenne | Bonne | Assez bonne | Considérable | Petite | — |
| 3. Scories + sulfate de potasse ... ... | Bonne | Assez bonne | Assez bonne | Moyenne | — | Petite |
| 4. Cyanamide de chaux ... ... ... | Bonne | Assez bonne | Assez bonne | Petite | Petite | Petite |
| 5. Scories Thomas ... ... ... ... | Assez bonne | Assez bonne | Bonne | Considérable | Considérable | Petite |
| 6. Témoin (sans engrais) ... ... ... | Assez bonne | Bonne | Assez bonne | Moyenne | Petite | Considérable |
| 7. Sulfate de potasse ... ... ... | Assez bonne | Bonne | Assez bonne | Petite | — | — |
| 9. Nitrate + scories ... ... ... | Bonne | Bonne | Bonne | Petite | Petite | Petite |
| 10. *Complet:* nitrate + sulfate potasse + scories | Bonne | Bonne | Bonne | Petite | Petite | Moyenne |
| 11. Nitrate + sulphate de potasse ... ... | Assez bonne | Assez bonne | Assez bonne | Modérée | Petite | Petite |
| 12. Engrais baladi (fumier) ... ... ... | Assez bonne | Bonne | Moyenne | Modérée | — | Moyenne |
| *Bata* 1912 (*Assili*). | | | | | | |
| 2. Nitrate de soude ... ... ... | Faible | — | — | Grande | — | — |
| 9. Nitrate + superphosphate ... ... ... | Assez bonne | — | — | Moyenne | — | — |
| 10. *Complet:* nitrate + sulfate potasse + superphosphate | Moyenne | — | — | Considérable | — | — |
| 11. Nitrate + sulfate de potasse ... ... | Assez bonne | — | — | — | — | — |
| 12. Engrais baladi (fumier) ... ... ... | Assez bonne | — | — | Moyenne | — | — |
| *Kafr-Soliman* 1913 (*Jannovitch*). | | | | | | |
| 2. Nitrate de soude ... ... ... | Assez bonne | Bonne | Assez bonne | Petite | Petite | Petite |
| 6. Témoin (sans engrais) ... ... ... | Assez bonne | Bonne | Assez bonne | — | Petite | Petite |
| 9. Nitrate + scories ... ... ... | Assez bonne | Assez bonne | Assez bonne | Petite | Moyenne | Considérable |
| 10. *Complet:* nitrate + sulfate potasse + scories | Assez bonne | Bonne | Assez bonne | — | — | Moyenne |
| 11. Nitrate + sulfate de potasse ... ... | Bonne | Bonne | Bonne | Petite | Petite | Petite |
| 12. Engrais baladi (fumier) ... ... ... | Assez bonne | Bonne | Assez bonne | Petite | Petite | Petite |

* Examen fait à l'Imperial Institute de Londres.

# TABLEAU XI.

## INFLUENCE DES ENGRAIS SUR LES QUALITÉS DE LA FIBRE.*

*Longueurs et Diamètres des Fibres, maxima et minima.*

| Nature des engrais | Longueur en inches | | | | | | Diamètre en 1/10,000 de inch | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Ecart | | Ecart | | Ecart | | Ecart | | Ecart | | Ecart |
| *Bata 1913 (Nubari).* | | | | | | | | | | | | |
| 1. Sulfate d'ammoniaque ... ... | 0·9—1·6 | 0·7 | 1·3—1·8 | 0·5 | 1·2—1·7 | 0·5 | 4·0— 9·0 | 5·0 | 4·0— 8·0 | 4·0 | 4·0— 9·0 | 5·0 |
| 2. Nitrate de soude ... ... | 1·0—1·8 | 0·8 | 1·0—1·8 | 0·8 | 0·9—1·6 | 0·7 | 4·0—10·0 | 6·0 | 5·0— 9·0 | 4·0 | 5·0— 9·0 | 4·0 |
| 3. Scories Thomas + sulfate potasse | 1·1—1·7 | 0·6 | 1·0—1·7 | 0·7 | 1·1—1·8 | 0·7 | 5·0— 8·5 | 3·5 | 5·5— 9·0 | 4·5 | 5·0—10·0 | 5·0 |
| 4. Cyanamide de chaux ... ... | 1·0—1·6 | 0·6 | 0·9—1·7 | 0·8 | 1·1—1·8 | 0·7 | 5·0— 8·0 | 3·0 | 5·0— 9·0 | 4·0 | 5·0— 9·0 | 5·0 |
| 5. Scories Thomas ... ... | 1·2—1·8 | 0·6 | 1·1—1·8 | 0·7 | 1·0—1·7 | 0·7 | 4·0—10·0 | 6·0 | 5·0—10·0 | 5·0 | 4·5— 9·5 | 5·0 |
| 6. Témoin (sans engrais) ... ... | 1·1—1·8 | 0·7 | 0·7—1·7 | 1·0 | 1·1—1·8 | 0·7 | 5·0— 9·0 | 4·0 | 5·0—10·0 | 5·0 | 5·0—11·0 | 6·0 |
| 7. Sulfate de potasse ... ... | 1·2—1·7 | 0·5 | 0·9—1·6 | 0·7 | 1·1—1·6 | 0·5 | 5·0— 8·5 | 3·5 | 5·0—10·0 | 5·0 | 5·0— 9·0 | 4·0 |
| 9. Nitrate de soude + scories ... | 1·2—1·7 | 0·5 | 0·8—1·6 | 0·8 | 1·0—1·8 | 0·8 | 4·5— 9·0 | 4·5 | 5·5— 9·0 | 3·5 | 5·0— 8·0 | 3·0 |
| 10. *Complet:* nitrate + sulfate potasse + scories | 1·0—1·6 | 0·6 | 1·2—1·8 | 0·6 | 1·1—1·7 | 0·6 | 5·0— 9·0 | 4·0 | 5·0— 9·0 | 4·0 | 5·0—10·0 | 5·0 |
| 11. Nitrate + sulfate de potasse ... | 1·1—1·6 | 0·5 | 1·0—1·6 | 0·6 | 1·0—1·6 | 0·6 | 4·0— 8·5 | 4·5 | 4·0— 9·0 | 5·0 | 4·5—10·0 | 5·5 |
| 12. Engrais baladi (fumier) ... | 1·0—1·5 | 0·5 | 0·9—1·8 | 0·9 | 1·0—1·8 | 0·8 | 5·0— 8·0 | 3·0 | 5·5— 8·0 | 2·5 | 4·0— 8·0 | 4·0 |
| *Bata 1912 (Assili).* | | | | | | | | | | | | |
| 2. Nitrate de soude ... ... | 0·8—1·7 | 0·9 | — | — | — | — | 4·5— 8·5 | 4·0 | — | — | — | — |
| 9. Nitrate + superphosphate ... | 1·2—1·8 | 0·6 | — | — | — | — | 5·0— 9·0 | 4·0 | — | — | — | — |
| 10. *Complet:* nitrate + sulfate potasse + superphosphate | 1·1—1·8 | 0·7 | — | — | — | — | 5·0— 8·0 | 3·0 | — | — | — | — |
| 11. Nitrate + sulfate de potasse ... | 1·1—1·7 | 0·6 | — | — | — | — | 5·0— 9·0 | 4·0 | — | — | — | — |
| 12. Engrais baladi (fumier) ... | 1·0—1·0 | 0·6 | — | — | — | — | 3·5— 8·0 | 4·5 | — | — | — | — |
| *Kafr-Soliman 1913 (Jannovitch).* | | | | | | | | | | | | |
| 2. Nitrate de soude ... ... | 1·0—1·7 | 0·7 | 0·9—1·7 | 0·8 | 1·1—1·7 | 0·6 | 5·5— 9·0 | 3·5 | 5·0—8·0 | 3·0 | 5·0— 8·0 | 3·0 |
| 6. Témoin (sans engrais) ... ... | 1·0—1·6 | 0·6 | 1·2—1·7 | 0·5 | 1·1—1·7 | 0·6 | 5·5— 8·0 | 2·5 | 5·5—9·0 | 3·5 | 4·5— 8·0 | 3·5 |
| 9. Nitrate de soude + scories ... | 1·0—1·8 | 0·8 | 1·1—1·7 | 0·6 | 1·1—1·7 | 0·6 | 4·0—10·0 | 6·0 | 5·0—9·5 | 4·5 | 4·0— 8·0 | 4·0 |
| 10. *Complet:* nitrate + sulfate potasse + scories | 1·1—1·7 | 0·6 | 1·2—1·7 | 0·5 | 1·2—1·8 | 0·6 | 4·0— 9·0 | 5·0 | 4·0—9·0 | 5·0 | 4·5— 9·0 | 4·5 |
| 11. Nitrate + sulfate de potasse ... | 1·3—1·8 | 0·5 | 1·1—1·6 | 0·5 | 1·1—1·7 | 0·6 | 4·5— 8·5 | 4·0 | 4·0—9·0 | 5·0 | 5·0— 9·0 | 4·0 |
| 12. Engrais baladi (fumier) .. | 1·0—1·7 | 0·7 | 1·2—1·7 | 0·5 | 1·0—1·7 | 0·7 | 5·0— 8·5 | 3·5 | 5·0—9·0 | 4·0 | 5·0— 8·5 | 3·5 |

* Examen fait à l'Imperial Institute de Londres.

## *Résultats détaillés.*

*Bata* 1913 (*Nubari*).

| Nature des engrais | Longueur des fibres en inches | | | Moyenne | Longueur en millimètres | Erreur probable de la différence | Diamètre des fibres en 1/100,000 d'inch | | | Moyenne | Moyenne en 1/1,000 de millimètre | Erreur probable de la différence | Valeur commerciale en 1/100 de penny par livre† | | | Moyenne en 1/100 de penny | Moyenne en P. T. par kantar | Erreur probable de la différence |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | | | | 1 | 2 | 3 | | | | 1 | 2 | 3 | | | |
| 1. Sulfate d'ammoniaque ... ... | 1·25 | 1·5 | 1·4 | 1·38 | 35·1 | 2·2 | 65 | 68 | 68 | 67 | 17 0 | 0·7 | 1025 | 1018 | 1005 | 1016 | 409 | 2 |
| 2. Nitrate de soude ... ... ... | 1·3 | 1·4 | 1·3 | 1·33 | 33·8 | 1·4 | 68 | 70 | 69 | 69 | 17·5 | 0·7 | 1025 | 1032 | 1018 | 1022 | 411 | 2 |
| 3. Scories + sulfate de potasse... .. | 1·4 | 1·4 | 1·4 | 1·40 | 35·6 | 1·2 | 67 | 71 | 66 | 68 | 17·3 | 0·6 | 1025 | 1018 | 1018 | 1020 | 410 | 2 |
| 4. Cyanamide de chaux ... ... | 1·4 | 1·4 | 1·4 | 1·40 | 35·6 | 1·2 | 66 | 67 | 71 | 68 | 17·3 | 0·6 | 1025 | 1022 | 1010 | 1019 | 410 | 2 |
| 5. Scories Thomas ... ... ... | 1·3 | 1·5 | 1·4 | 1·40 | 35·6 | 1·9 | 64 | 68 | 68 | 67 | 16·9 | 0·6 | 1025 | 1018 | 1010 | 1018 | 409 | 2 |
| 6. Témoin (sans engrais) ... ... | 1·5 | 1·3 | 1·4 | 1·40 | 35·6 | — | 68 | 70 | 70 | 69 | 17 6 | — | 1025 | 1032 | 1000 | 1019 | 410 | — |
| 7. Sulfate de potasse ... ... | 1·4 | 1·5 | 1·4 | 1·43 | 36·3 | 1·4 | 65 | 67 | 70 | 67 | 17·3 | 0·6 | 1025 | 1032 | 1018 | 1022 | 411 | 2 |
| 9. Nitrate + scories ... ... ... | 1·3 | 1·3 | 1·4 | 1·33 | 33·8 | 1·4 | 68 | 70 | 66 | 68 | 17·3 | 0·7 | 1025 | 1032 | 1012 | 1023 | 411 | 2 |
| 10. *Complet:* nitrate + sulfate de potasse + scories | 1·4 | 1·5 | 1·5 | 1·46 | 37·1 | 1·6 | 67 | 67 | 72 | 69 | 17·4 | 0·6 | 1025 | 1028 | 1000 | 1018 | 409 | 2 |
| 11. Nitrate + sulphate de potasse .. | 1·3 | 1·4 | 1·3 | 1·33 | 33·8 | 1·4 | 67 | 70 | 70 | 69 | 17·5 | 0·7 | 1025 | 1018 | 1012 | 1018 | 409 | 2 |
| 12. Engrais baladi (fumier) ... ... | 1·4 | 1·4 | 1·3 | 1·36 | 34·5 | 1·6 | 69 | 70 | 67 | 69 | 17·4 | 0·7 | 1025 | 1032 | 1010 | 1022 | 411 | 2 |
| *Bata* 1912 (*Assili*). | | | | | | | | | | | | | | | | | | |
| 2. Nitrate de soude ... ... ... | 1·3 | — | — | 1·3 | 33·1 | — | 64 | — | — | 64 | 16·3 | — | 1018 | — | — | 1018 | 409 | — |
| 9. Nitrate + superphosphate ... ... | 1·5 | — | — | 1·5 | 38·1 | — | 66 | — | — | 66 | 16·8 | — | 1028 | — | — | 1028 | 413 | — |
| 10. *Complet:* nitrate + sulfate de potasse + superphosphate | 1·4 | — | — | 1·4 | 35·5 | — | 64 | — | — | 64 | 16·3 | — | 1018 | — | — | 1018 | 409 | — |
| 11. Nitrate + sulfate de potasse ... | 1·5 | — | — | 1·5 | 38·1 | — | 66 | — | — | 66 | 16·8 | — | 1028 | — | — | 1028 | 413 | — |
| 12. Engrais baladi (fumier) ... ... | 1·3 | — | — | 1·3 | 33·1 | — | 64 | — | — | 64 | 16·3 | — | 1018 | — | — | 1018 | 409 | — |
| *Kafr-Soliman* 1913 (*Jannovitch*). | | | | | | | | | | | | | | | | | | |
| 2. Nitrate de soude ... ... ... | 1·4 | 1·3 | 1·4 | 1·36 | 34·5 | 1·4 | 71 | 68 | 69 | 69 | 17·6 | 1·2 | 1095 | 1078 | 1078 | 1083 | 436 | 2 |
| 6. Témoin (sans engrais) ... ... | 1·4 | 1·5 | 1·4 | 1·43 | 36·3 | — | 68 | 72 | 63 | 68 | 17·2 | — | 1100 | 1085 | 1078 | 1091 | 438 | — |
| 9. Nitrate + scories ... ... ... | 1·5 | 1·4 | 1·4 | 1·43 | 36·3 | 1·3 | 69 | 73 | 69 | 69 | 17·5 | 1·5 | 1100 | 1078 | 1072 | 1083 | 436 | 2 |
| 10. *Complet:* nitrate + sulfate de potasse + scories | 1·5 | 1·5 | 1·5 | 1·50 | 38·1 | 1·0 | 67 | 68 | 66 | 67 | 17·0 | 1·2 | 1100 | 1085 | 1078 | 1088 | 437 | 2 |
| 11. Nitrate + sulfate de potasse ... | 1·5 | 1·4 | 1·4 | 1·43 | 36·3 | 1·3 | 67 | 67 | 67 | 67 | 17·0 | 1·2 | 1100 | 1085 | 1072 | 1085 | 437 | 2 |
| 12. Engrais baladi (fumier) ... ... | 1·4 | 1·4 | 1·4 | 1·40 | 35·5 | 1·0 | 68 | 70 | 66 | 68 | 17·3 | 1·2 | 1100 | 1085 | 1078 | 1086 | 437 | 2 |

* Examen fait à l'Imperial Institute de Londres.

† Sur la base de 9·03d. par livre pour le "fully good fair" Avril).

On sait que l'homogénéité de longueur n'est pas indépendante des autres qualités de la fibre. En général les lots examinés étaient assez homogènes.

Je tire cette conclusion des observations qui accompagnent l'expertise plutôt que des chiffres qui mesurent l'écart existant entre la longueur maximum et la longueur minimum des fibres. Cette manière de faire conduit on le sait, à des appréciations erronées.[6]

A Bata (1913) les formules 2 (nitrate), 9 (nitrate + scories), 11 (nitrate et sulfate de potasse), et à un moindre degré la formule 12 (baladi) montrent une tendance à diminuer la longueur des fibres; tandis que la formule 10 (complet) semble devoir l'augmenter. Cependant l'étude de l'erreur probable de la différence ne donne pas une grande certitude à cet égard.

Ces données se confirment pleinement par les expériences de Kafr-Soliman (1913). Pour la même année, les mêmes formules ont exercé une influence semblable sur la longueur des fibres dans les deux régions.

Si nous comparons entre eux pour une même localité (Bata) les résultats de deux années différentes (1913 et 1912), nous constatons toujours la tendance des formules 2 (nitrate) et 12 (baladi) à produire des fibres de moindre longueur.

(*e*) *Diamètre* (voir Tableaux XI et XII).—L'influence des engrais sur le diamètre n'est pas très nette. La valeur des erreurs probables est assez considérable pour nous imposer une certaine réserve. On admet d'ordinaire que la résistance croit avec le diamètre de la fibre. Mes expériences indiquent que la finesse n'exclut pas la résistance. Elles montrent aussi qu'une augmentation dans la longueur ne correspond pas toujours à une diminution dans le diamètre.

Et inversement qu'une diminution dans la longueur n'implique pas une augmentation dans le diamètre.

En effet, les engrais azotés employés seuls n'ont pas altéré la finesse de la fibre.

(*f*) *Evaluation commerciale* (voir Tableau XI.)—C'est sans doute le point qui intéresse le plus le pro-

[6] M. Yves Henry, *loc. cit.*

ducteur et il est bon de faire observer tout de suite qu'il est la résultante non seulement de l'action des engrais, mais d'une foule d'autres facteurs. Les fumures n'y interviennent d'ailleurs que dans une faible mesure, ainsi que le démontre surabondamment l'évaluation commerciale.

Examinons, en effet, les prix accordés à chaque lot, en les étudiant pour chaque parcelle, tant à Bata qu'à Kafr-Soliman.

On est frappé tout d'abord par le fait que tous les cotons de la première parcelle de Bata ont été estimés au même prix, quelle que soit la fumure. Dans les deux autres parcelles de la même localité, les prix varient non seulement d'une formule à l'autre, mais aussi d'une parcelle à l'autre pour la même formule.

Les prix respectifs des différents lots de la parcelle No. 2 sont plus élevés que ceux des lots de la parcelle 3.

En moyenne tous les lots ont été cotés au même prix à 1 ou 2 piastres près, par kantar, différence insignificante.

A Kafr-Soliman, et bien qu'il s'agisse du Jannovitch, nous observons les mêmes faits qu'à Bata, et le prix moyen est encore ici plus uniforme.

On ne saurait trop insister sur l'importance des chiffres de cette évaluation commerciale; ils mettent fin, en effet, à des croyances gratuites suivant lesquelles quantité et qualité sont impossibles à réaliser à la fois dans la culture cotonnière.

Au contraire, ces engrais judicieusement employés pourraient améliorer les qualités de la fibre, et je n'en veux pour preuve que les remarques suivantes qui accompagnent le rapport d'expertise de l'Imperial Institute. Au sujet des Nubari, les experts font remarquer que les lots de la première parcelle " sont de qualité très satisfaisante, et de même valeur commerciale "; pour ceux de la parcelle 2 " qu'ils sont de bonne qualité, spécialement les Nos. 2, 6, 7, 9 et 12"; enfin pour les Nubari de la troisème parcelle, " qu'ils sont de bonne qualité, légèrement inférieurs à l'ensemble des lots des 2 parcelles précédentes; les cotons Nos. 2, 3 et 7 *sont les meilleurs*, tandis que les Nos. 6 et 10 contiennent la plus grande proportion de fibres faibles et irrégulières."

En ce qui concerne le Jannovitch de Kafr-Soliman, les mêmes experts les ont trouvés tous de "très bonne qualité; ceux de la première parcelle légèrement supérieurs aux autres, le tout présentant les mêmes défauts que les Nubari de Bata, à savoir une légère irrègularité dans la longueur et la résistance." Enfin les experts déclarent les Assili de Bata (1912) "d'excellent qualité dans l'ensemble; les Nos. 9 et 11 étant *légèrement supérieurs* aux autres au point de vue de la résistance."

Et l'on peut conclure que les engrais chimiques judicieusement employés exercent sur les qualités des fibres un effet favorable, tout en augmentant le rendement cultural.

## THE COST OF LABOUR AS AFFECTING THE COTTON CROP (ESPECIALLY IN THE UNITED STATES).

By JOHN A. TODD, B.L.

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THE problem of the increase of the world's cotton supply has been very much before the trade and the Government for the last fifteen years. A great deal of time and money have been spent in efforts to increase the supply by discovering and developing new areas suitable for cotton growing, and also by improving the conditions in existing areas. The time seems opportune, therefore, for a survey of the general conditions which have emerged, and the future possibilities which they indicate. The writer's point of view is naturally that of the economist, and the line of inquiry which it is proposed to follow in this paper may be indicated thus: Every country has among its own peculiar conditions at least one limiting factor which is the chief thing to be considered in estimating the possibilities of its future. To pick out and compare these limiting factors should be of interest, and may throw some light on the broad tendencies of the future development of the world's cotton supply.

Thus in Egypt the limiting factor has all along been the water supply available for irrigation. There has always been a neck-and-neck race between the maximum water supply and the area under cultivation. Again and again new irrigation facilities have been provided which seemed capable of meeting maximum requirements for some time ahead, but in an incredibly short time the *fellah* has again been crying out for more water. In the most recent case, the raising of the Assuan Dam, a single year has been enough, owing to an abnormally low and late Nile flood, to produce renewed water shortage in spite of the increased supply. It seems probable that this will always be the case.

In the Sudan the problem at first sight appears similar, but there are other difficulties which may become serious as the area under cotton increases. The labour supply was utterly depleted by the wars with the Khalifa, and in spite of the phenomenal rate of increase of Oriental countries, it is still very short. Wages are at present rather below the level of Egypt, which may be taken roughly at a shilling a day for ordinary agricultural labour; but it is easy to imagine what might be the effect of a too rapid extension of cotton cultivation in the Gezira leading to a scarcity in the labour supply. I am indebted to Mr. Lawrence Balls for a characteristic fact, namely, that the marriage dowry in certain districts has risen steadily from the sumptuary limit of £2 which was fixed by the Khalifa, until amounts as high as £50 have been recently demanded. A general rise in the standard of living, which this seems to indicate, might very well be followed by a rise of wages, which would seriously hamper the development of cotton growing.

In West and East Africa, including Nigeria, Uganda, British East Africa, and Nyasaland, the labour situation is very different. Cotton is cultivated almost entirely by native smallholders who are more or less independent; but if the value of their labour be judged by comparison with the rates paid for other work, such as in the ginning factories, it is very low. In Uganda, for example, the labourers in the ginneries are paid about 2d. to 3d. per day, and it is probable that in none of these areas does the average day's wage rise so high as the Egyptian figure of 1s. a day. In all these countries the chief difficulty is transport. The grower has to carry his crop on his head to the nearest market, from which it may find its way by road or river to railhead. After a long journey it at last reaches the seaport, from which it has still a long sea journey to Liverpool. The result is that for cotton which sells in Liverpool at 7d. to 10d. per lb. the grower receives probably not more than 4d. to 7d. In Nigeria, for example, the British Cotton Growing Association fixed buying price was raised not long ago to 1⅛d. per lb. of seed-cotton. As the ginning out-turn is only about 27 per cent. this means about 4d. per lb. of lint.

In India, again, wages are very low, and the chief difficulty is to secure the adoption of methods of cultivation and varieties of cotton which would increase the yield above the present beggarly average of about 100 lb. of cotton (lint) per acre. In China and Japan the conditions are probably similar to those of India. In Asiatic Russia, where cotton is grown entirely under irrigation, the limiting factor is again the water supply as in Egypt, though in certain districts where the old native type of cotton is largely or entirely grown we find a parallel to the Indian conditions. In Bokhara, a Russian tributary State, a curious state of affairs exists, under which the method of collecting the land revenue controls the situation. The land tax is assessed on the value of the crop, which cannot be removed from the field until it has been inspected and valued by the revenue officer. To avoid the damage which would result from the inevitable delay, cultivation is confined to the native type of cotton, the boll of which does not open when ripe, but has to be plucked bodily and opened afterwards by artificial means.

In South America, Brazil and Peru are fairly important cotton-producing countries. Regarding the former, the writer has little definite information. It seems to offer great possibilities for cotton growing, but the cost of living is very high and labour very poorly paid, resulting in low efficiency and high mortality. The chief hindrance to the extension of the crop seems to be lack of enterprise and the entire absence of modern methods of cultivation.

In Peru, cotton is grown entirely under irrigation and the limiting factor is the lack of capital for the development of irrigation facilities. Labour is comparatively costly, wages being stated in a report, dated 1911, as 2s. 6d. per day.

Coming now to the United States Cotton Belt, which still supplies about two-thirds of the world's cotton crop, we find a set of conditions entirely different from those in any other country in the world. The Civil War, so far as it really turned on the question of slavery, was fought on the issue that cotton is essentially a "cheap-labour crop," and that its cultivation without the supply of cheap labour which the slave system provided would be unprofitable, if not impossible. Of all the evils which the defenders of the South prophesied from the freeing of the slaves probably none has been so strikingly fulfilled as this. Negro labour under conditions of freedom has certainly not increased in efficiency; but its cost has gone up to a degree which even the gloomiest prophets could hardly have anticipated. A few figures will bring out the startling rise in the labour cost of the crop. The exact rates, of course, vary a good deal in different districts, but the following were obtained from an absolutely reliable source in Texas; and although the labour difficulty there is notoriously more acute than in the older parts of the Belt, the difference is only one of degree and is probably not sufficient to invalidate the argument. In any case, Texas already provides nearly one-third of the total American crop.

Most of the work of the cotton crop is done by day wages or piecework rates; but where men are employed as permanent hands the wage was stated at about $20 per month, or an average of $1 per working day, for they take Saturday off as well as Sunday. Day wages are anything from $1 a day upwards, but in the picking season the work is done on piece rates. These range in Texas from 60 cents per 100 lb. of seed-cotton at the beginning of the season, when there is plenty of cotton on the plants and picking is easy, up to $1 per 100 lb. at the end of the season, when the cotton is scarce and more difficult to pick. A good picker can do 300 to 400 lb. per day; 800 lb. in a day is recorded at a competition, but that was with assistance to carry away and weigh the cotton. Even at these prices labour is not easily obtained. In 1913 there was a special scarcity of labour in Texas owing to the Mexican War, which prevented the usual supply of transitory labour from across the border, with the result that in the first week of the picking season the pickers struck for 70 cents, and had to get it. In ordinary seasons the average cost of picking throughout the season is said to be about 85 cents. As the out-turn of lint from seed-cotton is about one-third, this means that the actual cost of picking the cotton alone is about $2\frac{1}{2}$ cents per lb. of lint. Considering that the average value of the cotton, taking into account the large proportion of lower grade cotton, probably did not exceed 10 or 12 cents per lb., even with the high prices prevailing in 1913; this means that the labour cost of picking alone is from one-fourth to one-fifth of the value of the cotton.

The total labour cost of the crop, as will be seen from the statement on p. 502, worked out at about $9·78 per acre. Estimating the crop at 200 lb. of lint per acre at 12 cents per lb., and taking into account the value of the seed, which at that time was not more than $20 per ton, the proportion of the labour cost of the crop to its total gross value ($28) is just under 35 per cent.

Two other illustrations may be given of the serious handicap imposed upon cotton growing in America by the cost of labour. Since the advent of boll weevil to the Mississippi Valley, where the best types of long staple cotton were grown, the Government experts of the Bureau of Plant Industry have devoted themselves to the selection or breeding of varieties which combine length of staple with good yield and early maturity; the latter is essential if the cotton is to evade the worst ravages of boll weevil by maturing at least a fair proportion of the crop before the weevil appears in its full strength in August and September. One type in particular, known as Durango, seemed to be specially suitable, but was found to possess a drawback which militated greatly against its general adoption, namely, a peculiar ingrowing habit of the lint in the boll which rendered picking slower and more difficult. This was enough to make the negroes practically refuse to pick the cotton, except at prohibitive rates, and the result is that the experts have been practically compelled to continue the work of selection until they can find some other variety which will combine the advantages of the Durango with the open growing character of the ordinary Upland cotton. In other words, America must select its cotton to please the negro.

Again, during the last few years great hopes have been entertained of the development of entirely new cotton-growing areas much farther west than the existing Belt, and practical success has already been achieved in two large areas, namely, the Salt River Valley in Arizona and the Imperial Valley in California. There, under irrigation, superior varieties both of long staple Upland and Egyptian have been produced which offered great possibilities; but the cost of picking, especially in the case of the Egyptian, was so high as to be practically prohibitive. The following quotation is from a Government report recently published: "The cost of picking Egyptian cotton was no less variable than the cost of production. On the irrigated land of the south-west the cotton plants grow very large with many branches. When loaded with a heavy cotton crop the plants bend over and become so entangled that it is difficult to get through the field. Where the acreages were small for each family no cash outlay for picking was needed. In the Imperial Valley, where labour was scarce and there was a lively demand for pickers in adjacent fields of short staple cotton, it was sometimes found necessary to pay from 3 to 3½ cents per lb. for picking. In the Salt River Valley, on the other hand, the labour supply was adequate and the bulk of the crop was picked for 2 cents per lb. *These prices, of course, refer to the seed-cotton.*" Taking the average ginning out-turn as one-third, this means that the cost of picking in these cases was from 6 to 10½ cents per lb. of lint. It only remains to add that the cotton fetched approximately 21 cents per lb., so that in some cases the cost of picking was actually one-half of the value of the lint.

Compare with this the cost of picking Egyptian cotton in Egypt, which is quoted in a recent report as P.T. 75 ($3·75) per acre yielding 5 kantars (say 500 lb.) of lint cotton, equivalent to a cost of ¾ cent per lb. of lint, against 6 to 10½ cents in California.

Had labour been the only extravagant item in the cost of production of cotton in America the situation might have been tolerable, but all the other items seem to be rising, too. Farm implements, horses and mules, and supplies of all kinds, including food both for man and beast, have gone up in price to a very serious extent. Thus, reverting to the Texas case, all the other charges except labour, *i.e.*, interest on and depreciation of capital, in the form of implements, plant, draught animals (but not the land itself), the cost of feeding stuffs, seed, ginning, and baling charges and supervision amounted to $11.34, or fully 40 per cent. of the gross value of the crop, leaving a balance of barely 25 per cent. to cover the landlord's rent. As a matter of fact, the rent in this case was exactly one-fourth of the crop under a crop-sharing agreement. This tenure is very common, and the landlord's share is rarely less than one-fourth. The result is that under these conditions it takes 12 cents per lb. to remunerate the grower fairly.

The situation gives some cause for anxiety, for it must be remembered that while the average yield over the whole of the America Cotton Belt is only about 200 lb. per acre, there are many small farmers whose yield is even less. The low yield is partly due to lack of labour; thorough ploughing and preparation of the ground are almost impossible, and the loss due to boll weevil might be considerably mitigated by picking up and burning the affected "squares," for example, if labour were obtainable at a reasonable cost. Again, while the basis price of Middling American cotton has in recent years touched very high figures, there has been an increasing proportion of low grade cotton. This, too, is largely due to the insufficient labour supply. During the picking season the American Cotton Belt is subject at times to very heavy rains, which damage the open cotton not only directly by the effect of the damp on the lint, but also indirectly by splashing mud up from the ground into the open bolls. This results in tinged or stained cotton, and the extent of the damage is due to the fact that there is not sufficient labour available to pick the cotton quickly when the weather is favourable. To those accustomed as the writer was to Egyptian conditions, it will be something of a shock to hear of ripe cotton being left hanging on the plants all through the winter, exposed to frost and rain. The writer heard of cotton being picked in March of the following year.

Even if a satisfactory mechanical picker were available—and, unfortunately, none of the types yet placed on the market can be regarded as satisfactory—it would not entirely meet the difficulty, which is most serious in the case of the small grower. They, of course, could not afford the necessary capital outlay, even if it would pay to invest so much capital on a small holding. As a matter of fact, most of the smallholders are only able to make ends meet at all under present conditions, because they are able to have the greater part of the farm work done by themselves or their families. If they were compelled to pay market rates for all the labour the crop requires they would soon be faced with bankruptcy. Last year, for example, the planter from whom the figures above quoted were obtained had a yield of only about one-third of a bale per acre, and, in spite of the high level of prices, a considerable portion of his crop, owing to its bad condition, fetched only 6 cents per lb. Under such conditions the life of the planter is simply economic slavery; he is only making a living out of his family. The idea which is very prevalent in this country, that, at present prices, cotton growing must be a very profitable business, is about as far from the truth as it could be, so far as America, or at least Texas, is concerned.

Making every possible allowance for the traditional grumbling propensity of the farmer these facts present a situation which calls for serious consideration. It means that under present conditions there must be a large proportion of the small growers who are working below the margin of profitable cultivation. This may be all very well for the negro planter, with his large family of small children, whose cost of subsistence is very low, and may be covered by the equivalent of one man's wage; but it will not do for the smaller white planters of, say, 50 to 150 acres, who now form a considerable proportion of the cotton growers in Texas, and who under better conditions might have been the hope of the cotton-growing industry. Something must be done if these men are to remain in the trade or others tempted to join them. It must be remembered that Texas and Oklahoma alone account for 75 per cent. of the net increase of area of the last ten years, and it is to them we must look chiefly for further extension.

Unfortunately, it is easier to point out the remedy than to secure its enforcement. There is no immediate prospect of any solution of the labour difficulty, for the supply of additional labour by immigration is swallowed up as fast as it comes. The difficulty can only be met by increasing the value of the crop, by raising the average yield, and improving the quality. The only alternative is a higher price, or at least the maintenance of a level of prices which we at present regard as excessive. The time is rapidly approaching, if it has not already arrived, when less than half a bale an acre of 10 or even 12 cent cotton will no longer pay the bulk of the planters.

That such an improvement, both in average yield and quality, is already possible is fortunately beyond doubt. New types of cotton which give a heavier yield of better staple cotton are now being placed on the market in considerable numbers; but much remains to be done in the way of improving the local conditions under which the crop is marketed in the districts, so as to secure to the enterprising farmer the full market value of superior cotton. This question and the closely allied problem of better baling methods in America are too big to be handled here; but the writer was convinced that the only thing which will lead to serious attempts being made to tackle these questions is the awakening of the spinners to the fact that something must be done, and that they ought to take a hand in the doing of it. What is wanted is closer relations between the producers and the consumers. The geographical distance between them has produced a state of mutual ignorance of each other's conditions and requirements, which is not good for either section of the trade.

If nothing is done it seems almost certain that the extension of the American crop will be seriously retarded. The writer does not wish to be unduly pessimistic, but it is well to remember that there are countries in the world where cotton could be grown to advantage but for the fact that labour is lacking. In the Argentine, for example, cotton growing might have been established on a large scale ere this but for the fact that labour is scarce and dear. Let America take warning if she would escape serious injury to her cotton crop. One cannot help wondering whether the future may not see a great redistribution in the chief cotton-growing areas in the world. The most striking development during the past thirty years has been the extension of cotton growing under irrigation, in Egypt, in India, and even in America, in the new regions of Arizona and California. May it not be that the next development will be a return to the supremacy of those countries where the uncertainty of the climate is mitigated by irrigation; and an unlimited supply of cheap labour is available to take full advantage of the ideal conditions thus secured? Cotton has always been a "cheap-labour crop," a "black man's crop." The negro labour supply in the United States is now insufficient and no longer cheap. It is doubtful whether the crop will pay for white labour. Is it safe to reject as absurd the idea that the day may come when it will no longer pay to grow cotton in the United States of the kind which at present forms a large proportion of the American crop, and that the future of the "bread and cheese" cotton supply of the world lies, say, in India?

### Estimated Cost of Production of Cotton in Texas in 1913.

Farm of 100 acres, held under crop-sharing lease, landlord taking one-fourth of cotton lint and seed. Yield taken as 200 lb. lint and 400 lb. seed per acre.

| | | |
|---|---|---|
| *Tenant's Capital.*—Horse, mules, harness, implements, wagons and miscellaneous plant $1,478.55. Interest thereon at 10 per cent. and depreciation at 12½ per cent. ... ... ... ... | | $332.67 |
| *Seed.*—75 bushels, at $2 ... ... ... ... | | 150.00 |
| *Labour.*—Two hands for six months, at $20 each ... | $240.00 | |
| Chopping cotton twice ... ... ... | 150.00 | |
| Picking 40 bales, at average 85 cents per 100 lb. of seed-cotton ... ... ... ... | 510.00 | |
| Weighing cotton, at 75 cents per bale ... ... | 30.00 | |
| Hauling cotton to ginnery, 24 days at $2 ... | 48.00 | |
| | ——— | 978.00 |
| *Ginning and Baling.*—Weighing at ginnery, at 10 cents per bale ... .. ... ... ... | 4.00 | |
| Ginning, baling, and wrapping, at $3 per bale ... | 120.00 | |
| | ——— | 124.00 |
| *Stock Feed.*—450 bushels corn, at 50 cents ... ... | 225.00 | |
| 365 bales hay, at 50 cents ... ... ... | 182.50 | |
| | ——— | 407.50 |
| *Supervision*, estimating the wages of a manager for 1,000 acres at $100 per month ... ... | | 120.00 |
| | | $2,112.17 |
| *Value of Crop*— | | |
| 40 bales cotton at, say, 12 cents per lb. ... | $2,400.00 | |
| 40,000 lb. seed, at $20 per ton ... ... | 400.00 | |
| | $2,800.00 | |
| *Less* one-fourth share to landlord ... ... | 700.00 | |
| | ——— | $2,100.00 |

# FIBRES.

## FIBRE INDUSTRY OF BRITISH EAST AFRICA.

By A. Wigglesworth.

Last summer I visited British East Africa in order to investigate the fibre industries in that country, and an account of my observations may interest the Congress.

British East Africa is one of the newest of British possessions; its administration by the Colonial Office dates from 1895. It covers an estimated area of 185,000 square miles, more than twice that of Great Britain. It has a white population of 4,000 to 5,000, mostly residing in the Nairobi district, and a native population estimated at 3,000,000.

The Protectorate stretches from latitude 4° South to above the Equator, and but for the fact that the land rises steeply from the ocean to a plateau at an altitude averaging 3,000 to 4,000 ft., the country would be of little interest to Europeans.

The scenery is varied and very beautiful, with an exceptional wealth of plant and animal life. Favoured as the country is by great varieties of climate, that of the uplands is not unlike an English summer, with comparatively small variation in temperature. There is a double rainy season, first March to June, then the small rains during November to December, making a total annual average of about 50 in. This double rainfall has an important influence on the growth of fibre. The rich volcanic soil has been rendered still more fertile by the deposit throughout many generations of forest humus.

First, let us take sansevieria. The discovery in the Voi district of vast areas of *Sansevieria Ehrenbergii* led to the first fibre industry in British East Africa. Pioneers found the natives splitting the stems into thongs of exceptional tensile strength, with which they bound together the framework of their grass huts, proving the utility of the fibre.

The Government granted concessions to cut the leaf, and three factories were erected to decorticate the fibre for the European market. A yellowish fibre is produced about 2½ to 4 ft. long, of good appearance, but somewhat brittle and lacking in strength.

The plant is found growing in thick clumps from a spreading, stout root; half-a-dozen or so stems spring from this, grouped fan-shaped, like iris leaves. The leaf reaches an average height of 4 to 5 ft., but exceptional plants are occasionally seen 14 ft. high.

The cutting is laborious, as the plant grows under low, thorny scrub, which must be cut with it. The native labourers have to go farther and farther afield, since the root generally perishes when the leaf is cut. In one plantation the cutting was taking place ten miles away from the factory, a line of rails and a locomotive having been imported to transport the leaf; in another a mono-rail is in use. Though sansevieria probably contains 15 per cent. of fibre, the machinery can only extract about 3 to 4 per cent.

The factories are built open-ended with a suction gas plant for motive power, the fuel consisting of charcoal made on the spot from local wood. A powerful crusher prepares the leaf for the decorticator, and it has been found that the Corona machine, made by Messrs. Krupp, gives the best results, producing, when worked at full speed for eight to nine hours, about 2½ to 3 tons of clean, dry fibre. This entails the transport of 80 to 100 tons of leaf per day.

When decorticated the fibre is spread in lines in the sunlight, and after a few hours' exposure is packed for export in bales of about 2 cwt. No washing is done.

Enormous deposits of waste, containing a large percentage of fibre, accumulate round the factory, and are a source of expense to remove. As this material contains much fibre rich in cellulose, it should make a valuable by-product for the manufacture of paper or celluloid. An enterprising pioneer erected a laboratory at Masongaleni to investigate the properties of this waste with a view to its utilization, but the problem remains unsolved, and is a fruitful field of research.

It was thought that land from which the sansevieria had been cut should be suitable for sisal. It seems, however, that the two plants grow under different conditions. Sansevieria does not thrive in the open. It prefers low scrub, under which it is sheltered from the sun. Sisal, on the contrary, must have sun, and will not grow well where there is shade. It does not appear to thrive on the poor land from which sansevieria has been cleared. The future of sansevieria may, therefore, be considered rather doubtful, and planters are justified in turning their attention to sisal for cultivation on the rich, volcanic soil of the uplands, where there are vast tracts awaiting cultivation.

It is an axiom that sisal flourishes best where the original bush has been thickest and has cost the most to clear. Sansevieria can do with little rain, as it stores much moisture in its thick, succulent leaf and has few pores (stomata) through which moisture escapes; but sisal almost ceases growing, and loses its glaucous appearance (the sign of health), after a few months' drought.

Sansevieria can be sold when Manila and sisal are scarce and dear, but brittleness discounts its value for manufacture into ropes and binder twine, and it is neglected and unremunerative when the standard fibres are plentiful and cheap. It costs more to produce sansevieria than sisal, while its selling price is 20 per cent. less.

I have observed that when subjected to the action of air and moisture (a natural dew retting) sansevieria becomes fine, white, glossy and more spinnable, and I consider it possible that some process may in future be evolved which will greatly enhance the value of the fibre and increase its uses.

And now as to sisal.

The following list of agave fibres of commerce is given by Mr. Lyster H. Dewey, Botanist in Charge of Fibre Investigations, Washington, D.C., U.S.A.:—

| Fibres | Plants | Botanical names | Region of production |
|---|---|---|---|
| Henequen ... | Henequen ... | *Agave fourcroydes* Lem.... | Yucatan |
| Mexican sisal | Sacci | *Agave elongata* Jacobi | Campeche |
| Yucatan sisal | Weis sisal | *Agave rigida* Hemsley | Chiapas |
| Sisal hemp | | *Agave rigida longifolia* Engelm. | Sinaloa<br>Tamaulipas |
| | | *Agave rigida elongata* Baker | Cuba<br>Bahamas |
| Sisal | Sisal ... ... | *Agave sisalana* Perrine ... | G. E. Africa |
| Bahama sisal | Yaxci | *Agave rigida sisalana* | B. E. Africa |
| East African sisal | Green sisal | Engelm. | Java<br>New Guinea<br>India<br>Hawaii<br>Fiji |
| Cantala ... | Cantala... ... | *Agave Cantala* Roxb. ... | Philippines |
| Manila maguey | Maguey | *Agave americana* Blanco | Java |
| Bombay aloe | Ananas sabrang<br>Kuntala | *Furcraea Cantala* Haw. | India |
| Mezcal maguey | Mezcal maguey | *Agave* ... ... ... | Sinaloa |
| Mazatlan hemp | Mezcal de Sinaloa<br>Mezcal azul | | Tepic |
| Tequila ... | Tequila azul ...<br>Tequila maguey | *Agave tequilana* Weber ... | Jalisco |
| Magueyon ... | Magueyon ... | *Agave* ... ... ... | Chiapas |
| Zapupe Fuerta | Zapupe de Tepetzintla | *Agave Lespinassei* Trelease | Vera Cruz |

There are about 300 varieties, and three of these supply the bulk of the fibre known to the world as sisal, viz.:—

*Agave rigida elongata*, Baker, known in Mexico as henequen, which produces about three-quarters of the world's supply of sisal.

*Agave sisalana*, Perrine.—This is the variety introduced into East Africa, and it was decided at the Surabaya Conference of 1912, and has been urged by Mr. M. M. Saleeby, that the name sisal should be confined to the product of this plant.

*Agave Cantala*, Roxb.—Cultivated in Java, producing a finer fibre than either of the two other plants. This it was proposed to name in commerce Cantala fibre.

Sansevieria has been a stepping-stone to sisal in East Africa. Sisal is superior to it in every respect. It is a hard, strong, whitish fibre extracted from the leaf of an agave. This plant was first discovered by Cortez in Mexico. He found the Aztecs and the Maya employing the agave for many purposes. They used the succulent young leaves for a vegetable soup, extracted the fibre from the mature leaf to be made into garments and for cordage purposes. From another variety they made a refreshing beer, still in use in Mexico, under the name "pulque," and they also extracted a herbal medicine.

Plantlets of *Agave sisalana*, Perrine, were with difficulty obtained in Mexico, and were introduced into Florida by Dr. Perrine in 1839, thence taken to the Bahamas in 1843 by Dr. Nesbit, and from there to the Hawaiian Islands in 1893. Dr. Hindorf imported 1,000 bulbils from Florida into German East Africa this same year. From there sisal was brought into British East Africa fourteen years later.

The first plantation (in British East Africa) was started in November, 1907, at Punda Milea, forty-five miles from Nairobi, by Mr. C. B. Hausberg, backed by Messrs. Swift, Rutherfoord and Co.

Bulbils were obtained from German East Africa, and were planted in nurseries while the ground was being prepared for them by top ploughing with a single furrow plough drawn by fourteen oxen. This team could plough half an acre in one day of eight hours. The second ploughing was done with a three-furrow disc plough with sixteen oxen, which turned over about two acres a day. The ground was planned out with chains, and planted 8 by 8 ft. to allow cultivation between the plants. This gives about 650 plants per acre, compared with 900 to 1,800 plants in German East Africa, and the production of fibre is as great from the smaller number of plants.

The leaves in the upland district are heavier than at the coast. It is found that eleven to twenty leaves, according to size, give 1 lb. of fibre, while at the coast it takes sixteen to thirty-five leaves to produce the same weight of fibre.

By October, 1911, over 800 acres were planted out, and the machinery was installed and started. The plant consisted of a suction gas engine and accessories for motive power, a New Corona decorticator, a primitive home-made beater in place of brushing machinery, and a Bijoli press for baling.

The growth of the plants has been so rapid that in many cases almost the whole of the leaves, about 180 in number, were available for cutting before the machinery was quite ready. The planter's skill consists in having mature leaves in sufficient number to keep the machinery steadily working, and in preserving a correct balance between leaf production and machine capacity.

No plantation could be found in better condition, the land being a model of cleanliness. One sees stretches of dark green, undulating landscape, clothed with a superb crop of well-grown, closely planted agave intersected with paths. The factory is well placed in a hollow near the centre. It is striking to see the even growth, the plants being tall enough on the average to conceal a man on foot.

The use of oxen is decidedly advantageous, facilitating the cultivation of the land. Catch crops can be grown, such as Rose coco beans planted between the rows the first and second year, and four crops can be harvested, thus materially reducing the cost of the sisal.

The leaf is ready after two and a half to three years' growth, and continues to grow for a further two to three years, making the cycle five to six years, and producing in all 140 to 200 leaves. One hundred leaves may be cut at a time, but generally twenty to eighty are sufficient. These are tied into bundles, and are transported on a trolley line to the factory.

The process of decorticating sisal is simple, and involves the crushing of the leaf while it is automatically gripped near its centre. Modern machinery enables the cleaning process to be done in one operation.

After passing through this machine the fibre is taken to a washing tank, where it is thoroughly rinsed in water for forty-five minutes[1] before being carried to the drying

[1] By some it is deemed necessary to leave the fibre in water not more than three or four minutes, so as to keep it white and prevent loss of strength. Abundant water supply is *most important*. In Java the Cantala fibre is subjected after decortication to a process of retting (fermenting in water) for three or four days, and while this improves the colour, it depreciates the strength nearly 50 per cent., and cannot be recommended either for this or for sisal. Further, in Java a system of purifying the washing water by chemicals has been adopted. A fine white fibre (the whitest known) is obtained, but it is questionable if the expense justifies the result.

field. It is important that the water be frequently changed if the white fibre is to be obtained, colour being of value. After washing the fibre is carried to the drying ground, where a few hours' exposure in the hot sunshine suffices in good weather. If left after being thoroughly dried the fibre will tend to turn yellowish in colour. If packed before being bone dry, it appears to deteriorate in transit through discoloration.

When well dried the fibre is taken to the brushing machine, after which the product is tied with a wisp of fibre into heads of about 5 lb. each, say 4 in. diameter, to facilitate handling in the rope and twine factory.

A new brushing machine, the invention of Mr. Dwen, of Messrs. Swift, Rutherfoord and Co., constructed by Shirtliff Bros., of Hampton Hill, has made a step in advance, saving wastage and labour. It is constructed with an automatic grip on similar lines to that in use on the decorticator.

The standardizing of qualities in the factories into the following grades:—

Prime long,
,, medium length,
Good long,
,, medium length,
Tow,

is favoured by consumers, and is likely to become universal in British East Africa. It obviates disputes, and saves the expense of arbitration where deliveries of fibre are ungraded. After grading the fibre is neatly packed in bales of 2 cwt. each, the contents being 80 to 90 cubic ft. to the ton weight.

A stout cord made from the sisal itself is strong enough for baling purposes. Hoop-iron is not recommended, as it cuts the fibre if the hydraulic pressure be excessive. It is essential that the fibre be tightly pressed, seeing that freight adds considerably to the cost. Freight from East Africa to U.S.A. is much higher than that from Mexico to New York, and it is important that those who are interested in the development of East Africa should encourage the shipping companies to give every possible facility in the way of cheap freights, so that the new industry may not be hampered. The tendency is to keep freights far too high, and this must be remedied.

Mr. A. C. MacDonald, the able Director of Agriculture for British East Africa, has investigated the production of sisal in Punda Milea, and finds that a total weight of three tons per acre is produced during the life of a plant which averages four and a half to five years and occasionally six years. His experiment has been verified and even bettered by subsequent practice.

In this district it is by no means an easy task to eradicate the sisal "bol" or stump before replanting or preparing the land for another crop. In German East Africa this rots away of itself within a year. At the coast in British East Africa a vigorous jerk will remove the stump, but in the uplands, nourished by the rich soil, the stump is formidable, and can only be extracted by pulling out with four to six oxen yoked to a short rope which is hitched round the root, a second rope at the same time being slipped round another plant, so that the strain on the oxen may be steady and the work be expeditiously done.

Mr. A. C. MacDonald experimented with dry arsenite of soda, which kills the stump and facilitates its removal.

The ground wants a thorough cleaning, and it is considered prudent to leave it fallow a year, or to take a couple of bean crops before replanting.

In German East Africa three consecutive crops have been grown, the second and third yielding rather poorer fibre than the first. To what degree soil is exhausted by sisal has yet to be proved.

Elaborate experiments in fertilizing were carried out at Amani (German East Africa), where it was ascertained that sisal did not benefit by any kind of fertilizer.

In 1908 a plantation was started by Messrs. Mildmay and Wavell at Nyali on the mainland, opposite the island of Mombasa. It comprises a long strip of coast land of coral formation, more suitable for sisal than for any other crop. The labour of clearing was considerable. No ploughing could be done, so the ground had to be prepared by the native "Jembie" (hoe), the presence of the tsetse-fly preventing the use of draught animals.

The bulbils were procured from India and locally, and were planted out by Swahili and Kikuyu natives.

The average rainfall here is 50 to 60 in. and it is fairly regular, depending on the monsoon winds.

The sisal is planted out on prepared land immediately after the rains. Originally bulbils were chosen, but now suckers are preferred, and are planted out directly without passing through a nursery. Further, sisal suckers are preferred at the coast because they are true to the parent type, and if selected from the best plants reproduce a pure type; whereas bulbils, through crossing, contain more than one strain and are liable to greater variation. The spacing is closer than in Punda Milea, up to 1,400 plants per acre. It is found that plants grow best in exposed positions, better on hilltops than in valleys, and that they thrive best where they have most room, consequently wider planting is now being advocated, some coast planters adopting 8 by 8 ft., or about 650 plants per acre. At the coast sisal may be interplanted one year before it poles, so that the crop matures a year earlier. Care is taken to keep the land as clean as possible during the first year until the plant can fend for itself. After this little harm can happen to sisal. Owing to the nature of the ground the cost of clearing is considerable, amounting to £3 to £5 per acre. Once cleared, it can be kept clean with an outlay of about 20s. per annum.

After three years' rapid growth the leaves are 3 to 4½ ft. long and are fit for use. One man, working by contract, can cut and remove the terminal spine from 1,200 to 1,500 leaves per day. A really good cutter can prepare 3,000. The leaves thereafter are carefully selected as to length before tying into bundles of 40 to 50 lb. each.

Paths intersect the estate, dividing it into 10-acre lots, with roads at intervals wide enough for a trolley line to convey the leaf to the factory. The leaf contains so small a percentage of fibre that 60 to 70 tons must be handled to produce 2 to 2½ tons of dry fibre each day. To effect economy of labour locomotives are now being used to facilitate traction and save labour, which is as scarce in East Africa as elsewhere.

The plant grows best where there are pockets of broken coral soil, and an occasional leaf may measure 63 in. On flat coral rock the plants are stunted with matted roots, which spread outwards, joining the roots of plants in the next row. Small patches of ground occur here and there where sisal will not grow. This causes irregularity, and entails in this district the selection of the leaf into various lengths before decorticating.

As many as 180 leaves have been cut from one plant; others have poled after only 130 were taken, while the average number in practice may be reckoned at 140 to 150 leaves. When mature the pole or seed bearer shoots up with incredible rapidity to a height of 15 to 20 ft., and produces up to 3,000 bulbils.

After cutting the leaves are transported to the factory. A New Corona has been erected, the brushing is done by converted raspadors, and the baling in a hydraulic press made by Hollings and Guest.

The sisal is graded as at Punda Milea; the fibre is perhaps rather finer, the colour and quality are excellent, and the produce finds a ready market at the price ruling for German East African sisal.

An area of 1,200 acres has been planted, and 700 to 800 are at the cutting stage. The machinery was started in January, 1913, and two other sets are being fitted up.

In many estates it is found advisable to allot to the native a fixed task, and on its completion he may return home or may continue working at the same rate of pay. Work starts in some at sunrise, and continues without intermission until four in the afternoon. A good worker may complete certain tasks by two or even at noon, after which his time is his own. Wages at the coast are higher than at the uplands, averaging 12 to 14 rupees (16s. to 18s. 8d.) per month, against 6 to 8 rupees (8s. to 10s. 8d.).

At Nyali a feature is made of good housing for the natives, and stone huts have been built. In other estates the native erects his own grass hut in the traditional way.

These two estates are typical of others in British East

Africa. The industry has taken a firm root. Planting proceeds apace, and it should not be many years before British East Africa catches up German East Africa, which has had fourteen years' start, and whose best estates are highly profitable and yield large returns.

In other tropical countries they deem it inadvisable to cultivate sisal over 1,500 ft. altitude, but British East African planters have proved that an excellent crop can be obtained at 5,000 ft., and are now going farther afield, planting sisal at Naivasha at about 7,000 to 8,000 ft. altitude. It is too early to ascertain the result.

Almost close to the Equator, just above Lake Victoria Nyanza, a successful plantation is using raspadors, this being the first machine adapted for the cleaning of sisal, the invention of a Franciscan monk, and still in use in Mexico. The fibre from this district is rather longer and of good colour, though at times a slight defect is visible, due to the pitting of the leaves from the storms which occur in that district.

Mention should be made of a plantation at the coast north of Mombasa, where a decorticator constructed by Messrs. Robey and Co., Ltd., is at work.

It is still to be proved whether the coast plantations or those in the uplands will be more profitable. It has been shown that the conditions are quite different. The rich upland soil can produce any crop, and the land will therefore rise in value. This may cause the cultivation of sisal to be eventually confined to the cheaper coral lands of the coast, or, as in German East Africa, to the medium soils.

The weeding of the coral coast land entails more labour and expense than in areas where the soil can be cultivated by draught animals and mechanical tools, such as the Planet Junior cultivator now in use in the upland district, and a valuable accessory in view of the scarcity of labour. It is doubtful if any great harm is done after the first year by neglecting to keep the land quite clean. The vitality of the agave being greater than that of the weeds enables it to hold its own and thrive, in spite of its enemies. Naturally work has to be adjusted according to the available labour supply, and in many plantations in German East Africa no great stress is laid on cleaning the sisal after it has entered its second year. My visit there took place after the heavy rains, when the weeds had the greatest hold, and it was anticipated that several months would elapse before the plantations could be weeded. The cost of cleaning is very variable. Where cultivation can be done by machinery, as in the Highlands, the cost may be as low as 10s. to 20s. per annum, but at the coast it is greater, and in some parts of German East Africa land can only be kept clean at a charge of 50s. per acre per annum.

Both in British and German East Africa only *Agave sisilana* has been planted, and neither the Mexican variety nor the Cantala. Though producing a fibre analogous in appearance to Mexican sisal (henequen or *Agave rigida elongata*), *A. sisalana* is botanically an entirely different plant, as can be judged from the shape of the petal of the flower, and the fact that the leaves of the henequen have spikes along the edge as well as at the end.

The African plant commences to mature in two and a half to three years, and its cycle is five to six years, whereas the Mexican plant matures after seven to eight years, and is said to attain the age of 20 to 25 years. It grows more slowly and produces about twenty-five leaves each year, as against fifty to eighty leaves of African sisal. An acre in Mexico turns out 1,000 to 1,500 lb. per annum of clean fibre, whilst a ton has been gathered in one year in the uplands of British East Africa. Further, whereas the soil and climate of Africa enable the plant to produce three tons of fibre in a cycle of five to six years, in Mexico it takes ten to twelve years to obtain this same quantity of fibre. Mexico has the benefit in so far as the plantations do not require renewal so often, against which expenses in Africa are lower. The practice in Mexico is shrouded in mystery and wants investigating, but it is certain that the conditions in East Africa are more favourable, and can therefore produce sisal at a lower cost than Yucatan or Campeche. Sisal cannot be profitably cultivated in patches, since less efficient machinery is available to cope with a small production. It is therefore inadvisable for a man of limited means to engage in its cultivation. It has been suggested that a group of settlers plant each, say, 100 acres, and combine to instal an up-to-date plant at the centre of their plantations worked on a co-operative system. In practice it may be difficult to work out this scheme.

A good modern machine, such as the New Corona, produces from two to two and a half tons of cleaned fibre in a day of six to ten hours. To keep it going, say 200 days in the year with 60 to 70 tons of leaf per day, five to six hundred acres must be cut out in a year in German East Africa.

In the uplands of British East Africa 300 to 400 acres will supply the annual consumption of a Corona machine, and it is sufficient to plant 900 to 1,000 acres. An area of 1,500 acres may be reserved for each machine, one-third of this to lie fallow.

In German East Africa it is reckoned that £20,000 capital is necessary to bring the plantation to bearing point, supply the necessary machinery, and leave a margin for working capital. A smaller sum should suffice in the British East African uplands, where labour is cheaper and the land worked with a smaller expenditure of labour.

It is evident that where machinery and oxen can be used for cultivation, and therefore little need be expended for clearing, the cost of producing sisal is below that where the ground must be tilled by hand, either for lack of animals or because of the nature of the soil. In compensation, barren, rocky land can be obtained at a lower cost.

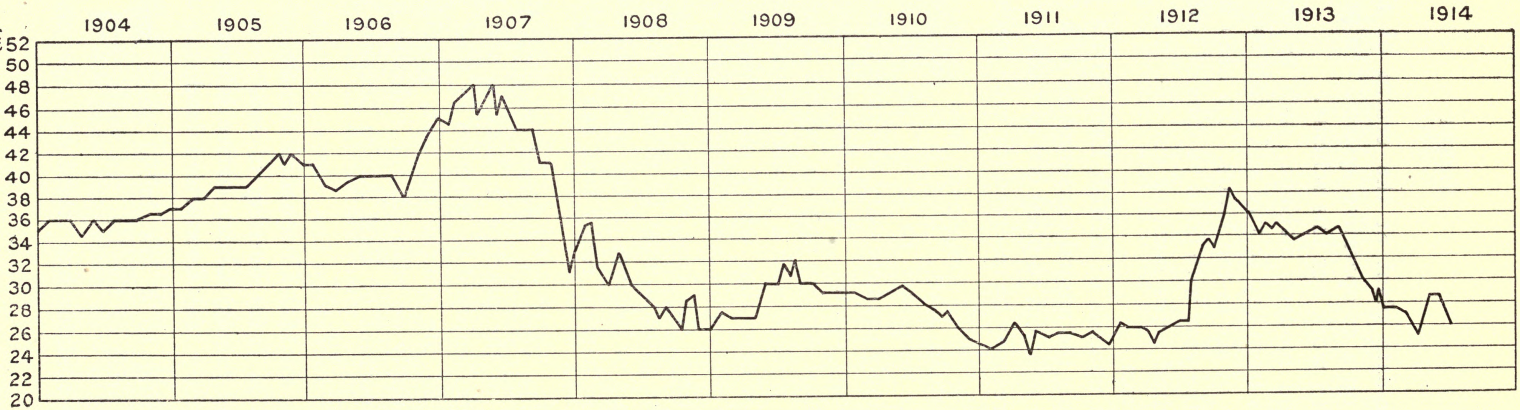
Methods vary in different sisal-producing countries. A study of the practice in Mexico and Java reveals the advantages enjoyed by planters in East Africa, and contributes to the conclusion that, provided an adequate labour supply be ensured, the industry must become the most important of East Africa because of its unrivalled conditions, viz.:—

(1) Unequalled climate,
(2) Fertility of soil,
(3) Cheap native labour,
(4) Low-priced land,

contributing to a low initial cost, compared with the average price of the last ten years, £33 per ton.

Fluctuations in Value of German East African Sisal in £ per ton c.i.f. Hamburg.

(Average price of German East African Sisal during ten years 1904–13 = £33 per ton c.i.f. Hamburg.)



It may be asked what influence the increased production will have on prices. The world's total consumption of hard fibres, which comprise Manila, sisal, and New Zealand hemps, used mostly for rope and binder twine, is now 360,000 tons per annum, and is increasing at the average rate of 4½ per cent. per annum, say 15,000 tons

ANNUAL PRODUCTION OF HARD FIBRES.

| | 1913. Tons | 1912. Tons | 1911. Tons | 1910. Tons |
|---|---|---|---|---|
| Manila Receipts | 118,250 | 172,000 | 158,000 | 170,000 |
| Mexican Sisal | 142,250 | 139,823 | 120,000 | 97,000 |
| Istle or Tampico | 10,383 | 11,274 | 7,753 | — |
| German East African | 22,000 | 16,000 | 10,000 | 7,000 |
| Java Sisal | 7,500 | 6,000 | 2,000 | 1,000 |
| Bahamas (est.) | 3,000 | 3,000 | 3,600 | 3,000 |
| New Zealand | 30,000 | 21,500 | 18,100 | 21,000 |
| | 333,383 | 369,597 | 319,453 | 299,000 |

annual increase. If excessive quantities of sisal be suddenly thrown on the market without any curtailment of production elsewhere a fall in price may take place, but the cheapest producer must of necessity displace others who through antiquated methods or less suitable conditions are unable to compete favourably.

New methods must displace old, and Africa is well suited to produce fibre. Its soil, climate, and labour conditions cannot be improved upon, and there is no reason why Africa should not supply the future fibre requirements of the world.

Labour conditions in Europe and America are daily becoming more unsuited to the production of fibres. The peasants of Russia, Germany, and France are curtailing the growth and retting of hemp, and in Great Britain it has been abandoned. Legislative grants will not suffice to reinstate it. The cultivation is slowly but surely receding from Europe and migrating to Asia and Africa. Only if new processes be evolved with odourless retting and scientific treatment in well-equipped factories may this industry survive in Europe. Hard fibres are slowly but surely displacing "soft" fibres (Italian, Russian, Hungarian) for cordage purposes.

We are on the verge of a change, and it is not hazarding much to predict that Africa is likely in the near future to be the largest producer of sisal and other fibres.

## JUTE AND ITS SUBSTITUTES.

By R. S. Finlow.

*Fibre Expert to the Government of Bengal.*

The cultivation of jute and the manufacture by hand of jute cloth called gunnies (from *goni*, a sack), of ropes, and probably also of jute paper, are very ancient practices, the dates of commencement of which are lost in antiquity. The first exports of raw jute which were the origin of the great jute industry of to-day apparently took place as recently as the first quarter of the nineteenth century, when a few hundreds of maunds were forwarded to Europe. Long before this, however, jute was cultivated on a large scale, at least in Northern Bengal in the districts of Rangpur, Dinajpur, and Purnea; but all the raw product was worked up in India, partly into clothing (*megili*) for the inhabitants of Bengal, partly into sacking and wrappers (*gunni*), and partly into ropes and cordage. In 1746 an entry in the log of the ship *Wake* runs: "Sent on shore 60 bales of gunny belonging to the Company, with all the jute ropes." In 1804 Buchanan Hamilton, in his manuscript accounts of Rangpur, says: "In this district one of the most extensive crops is the 'jat pata,' or *Corchorus capsularis*, used in the same manner as in Dinajpur. For the manufacture of the better kinds of paper 'tangsa,' or 'tosha pata' (*Corchorus olitorius*), is more usually cultivated. In every part as much is cultivated as is required for the use of the farms; but in the north-western parts of the country great quantities are exported (to the neighbouring districts), both raw and manufactured, and a great part of the people are clothed with cloth made of this material." The extent of the cultivation of jute in Northern Bengal can be gauged from Buchanan Hamilton's estimate that at the time of writing—about 1804—the area under jute in Rangpur approximated to 20,000 acres. Incidentally, he relates that the price of jute varied between As. 8 and Rs. 2 per maund. Even in those days apparently there were considerable fluctuations in the price of the fibre, but the general level of the values was obviously low enough to excite the envy of modern jute manufacturers.

In 1828 a separate head was assigned to jute in Customs House records, and it was introduced to Dundee about 1830. At first spinning experiments with jute in Dundee do not appear to have been successful, and it was not for some years that it was manufactured to any extent by itself. At this period its admixture with other material gave rise to the significant phrase "Warranted free from Indian Jute" in contemporary market quotations (*vide* Wallace, "The Romance of Jute," Calcutta, 1909). About the year 1838 the spinning difficulties appear to have been surmounted, and jute began to take its place as the cheapest material for the manufacture of sacking and of common wrappers. From that time onwards the rapidity with which exports of jute from Calcutta increased was remarkable. In 1829 only about 380 cwt. were dispatched. This increased to 1,800 cwt. in the following year; while the average annual export in the period 1828 to 1833 was 11,800 cwt.

TABLE I.

EXPORT OF JUTE FROM BENGAL.

| Period | Annual export of jute. Cwt. |
|---|---|
| 1828–33 | 11,800 |
| 1838–43 | 117,047 |
| 1848–53 | 439,350 |
| 1855–56 | 882,700 |
| 1860–61 | 1,074,320 |
| 1874–75 | 5,493,957 |
| 1878–79 | 6,021,382 |
| 1882–83 | 10,348,909 |
| 1897–98 | 15,000,000 |
| 1911–12 | 16,150,000 |

The Crimean War and the consequent temporary shutting off of the Russian exports of flax and hemp, the most serious competitors of jute in the gunny market, gave jute an impetus which it has never lost.

The export of jute touched 15,000,000 cwt. in 1898, since when the figures have remained, on the whole, about stationary. In the meantime the great increase in the production of jute has been almost entirely absorbed by the Indian mills, which have practically doubled their consumption of fibre. About the year 1855 the first Indian jute mill was established. To-day there are forty-five mills in Bengal, employing over 200,000 people, and consuming, on an average, fully half of the total quantity of jute produced.

Jute can be grown in almost any type of soil which has the necessary depth, provided fertilizing material is available; as well as sufficient water, either in the form of rainfall or of irrigation, to keep the soil moist. Its experimental cultivation in different parts of India has dissipated the idea, long held by nearly all who are not well acquainted with the practical details of its cultivation, viz., that a swampy soil and an excessively damp atmosphere are necessary for its successful growth. As a matter of fact, the finest jute is grown on land which never goes under water, and the quality of the fibre produced with irrigation under the almost arid atmospheric conditions prevailing in the Punjab left nothing to be desired. The best crops of jute cannot be raised on shallow stony land or on the acid red laterite soils which are to be found in the "Bahrind" and Madhupur jungle tracts in Bengal, Chota Nagpur, and Orissa. Outside these tracts the crop thrives well in most parts of Bengal and Assam, but best of all perhaps on the rich alluvial areas in Eastern Bengal, which are renewed every year by the silt brought by the floods from the rivers which inundate them. On lands which receive such an annual deposit of silt the cultivators are in the habit of using little or no manure, and yet, provided weather conditions are favourable, they reap large crops every year. On lands which are not submerged by river floods fairly heavy manuring is necessary, for the green weight of a good crop of jute may be anything from 15 to 20 tons (say 400 to 600 maunds). As practically the whole of this growth takes place within three months, it is obvious that plenty of easily available plant food is necessary. The whole question of the manuring of jute is under investigation, and it is probable that it may ultimately be possible to increase materially the average yield per acre of the fibre.

The time of sowing of jute varies from the middle of February in low-lying "Char" lands to the beginning of June in the high western and south-western districts, where sufficient rain often does not fall before the latter date to admit of sowing. The land is usually prepared by alternate use of the plough and *mooi* or *henga*,[1] until a sufficiently fine tilth has been induced. The amount of labour involved in this varies considerably, of course, with the nature of the soil. Low-lying bheel soils are similar to lands subject to immersion from river flood, in that they receive the silt and drainage from higher surrounding lands. They are not usually manured. Intermediate lands which are submerged in the rains, but which receive little or no silt—these are typical paddy lands—are manured for jute, and in the Rangpur district, for instance, commonly only grow jute for about two years out of five. A rotation for such land might be:—

| | |
|---|---|
| 1st year ... ... ... ... | Jute (manured). |
| 2nd ,, ... ... ... ... | Jute (not manured). |
| 3rd ,, } 4th ,, } 5th ,, } ... ... ... ... | Paddy. |

On high lands which are never submerged it is the custom to manure for each crop of jute.

Practically the only manure in use at present for jute, as for all other crops in Bengal, is cow-dung mixed with ashes and other house refuse. A common dressing of such manure is from 50 to 75 maunds per acre; but in some cases 100 maunds, and even 150 maunds, are supplied per acre. The manure is spread as evenly as possible on the land, and ploughed in before sowing. Recent important work by the Agricultural Department of the Government of Eastern Bengal and Assam points

[1] A *mooi* is a bamboo instrument rather like an ordinary ladder, about 7 ft. long, which, with the driver standing on it, is drawn over the land, serving the double purpose of a roller and leveller. The *henga* is a plain log of wood put to a similar use in the more westerly districts.

to the probability of profitably increasing the out-turn of crops in general, including jute, by the application of lime and phosphates, in which important food constituents there appears to be a general deficiency in the soils of Bengal. In view of this deficiency of lime, the addition of household ashes to the farmyard manure is a matter of no little importance, as they contain all the mineral constituents of the organic materials of which they originally formed part. Potassium carbonate and calcium carbonate are both important constituents of wood ash. They are both powerfully basic, and would, therefore, always tend, in however small a degree, to neutralize acidity of the soil, an unhealthy condition which may be said to be directly due to lack of lime.

Immediately before sowing the land is usually ploughed once, after which the seed is scattered broadcast at the average rate of 8 to 10 lb. per acre. The land is then either levelled at once with the *mooi* or *henga*, or it may again be ploughed crosswise before the use of the *henga*. The latter is advisable if the moisture is not very good. Experience suggests that the following method gives a more even germination: Plough first and level the surface with the *henga* or *mooi;* then sow on the even surface. If the moisture is very good and likely to remain so it is sufficient to rake (Bengalee, *achra*) or harrow the seed into the soft soil either once or in two crosswise directions, the surface being afterwards consolidated by the *henga* or *mooi*. If the moisture is not good the plough may be used instead of the rake after sowing. Of course, it follows that if the plough is used a considerable proportion of seed is buried very deeply, and a good deal of it may not be able to germinate. It is therefore not uncommon amongst cultivators to use six seers (12 lb.) of seed per acre. With good moisture, and if the seed is only raked in, three seers (6 lb.) of thoroughly good seed per acre give an amply thick germination.

After germination, when the young plants are from 1 to 2 in. high, it is highly advisable to pass a rake through the field. In the jute districts the *achra*, or rake, is commonly made of bamboo; but the ones in which the essential parts are made of iron are perhaps more useful and, of course, far more durable. The *achra* is equally useful with *aus* paddy as with jute. Both crops are sown at a time before the land has become sodden with moisture, so that if there is a fine spell after rain the surface of the soil tends to harden, forming a *papri*, with the result that the growth of the young plants is retarded. The action of the bamboo rake is threefold. Firstly, it tends to keep the surface of the soil loose. Secondly, when used at this stage it frees the land from young weeds which are just coming up. Thirdly, it also, of course, takes out a considerable number of young jute plants. There is a little doubt that cultivators who are in the habit of using the rake purposely sow rather more seed than is necessary, so that they can afterwards afford to lose a considerable number of jute plants in getting rid of all weeds by repeated raking. In this way raking greatly eases the subsequent weeding and thinning operations, which are about the most expensive items in the cost of jute cultivation. When large areas of jute and of *aus* paddy require weeding and thinning within a particularly short space of time, as happens in some years when the weather has not been quite favourable, it is quite common for men labourers to receive from As. 12 to Re. 1 a day, and boys As. 8 to As. 12, according to their size. With such prices the cost of weeding, if it has to be paid for entirely in cash, may approach Rs. 20 per acre. Of course, there are very few, if any, cultivators who would have to pay so much, and, as a rule, by helping each other, the greater part of the labour is carried through without any actual circulation of cash. This is one of the reasons why Government Experimental Farms, which have to pay maximum prices for all labour, are often unable to produce a balance sheet which would indicate to cultivators the nature of the profit to be made on the cultivation of a particular crop.

After the weeding and thinning operations there is nothing to be done until the crop is ready to cut, which is well after the commencement of the monsoon. In the interval, on low-lying tracts, the land, partly owing to heavy rainfall, but chiefly, as a rule, to rise of the rivers, becomes submerged to a greater or less depth, and it is not at all uncommon to see men cutting jute standing in water which is waist deep. Some jute is cut very young in order to prevent its entire destruction by a sudden rise of the rivers. The jute which comes into the market before the middle of July is usually immature, and may be a hastily reaped crop or the produce of a late thinning operation.

The great bulk of the jute crop may be said to be cut at about the time when the flowering stage is approaching completion, from the middle of July to the end of August, and it may be taken that before this the crop is immature. There are several advantages in cutting at this stage, viz.:—

(*a*) The crop has practically reached its maximum height, so that the yield of fibre is also approaching its maximum.

(*b*) The quality of the fibre is rather finer than at later stages.

(*c*) The retting process is considerably shorter, partly on account of the higher temperature of the water, and partly because of the greater succulence of the plant.

The cutting of jute is carried out with a crescent-shaped knife, with a toothed edge, rather similar to a small European sickle. The cut stems are tied in bundles, and, as a rule, are immersed at once, especially in flooded districts. In Western Bengal, however, on high land, it is the custom to place the bundles on the ground close together in a long line, so that the upper leafy portion of one bundle covers the bare stem of the bundle underneath. In this way a sort of fermentation seems to take place, for the stems "sweat," becoming greasy to the touch, and the retting process subsequently takes place more quickly and more evenly. After immersion retting may be complete in a week to ten days in the hottest part of the season, when the temperature of the water often exceeds 85° F. With older plants, however, and more especially if the water is becoming cooler, *e.g.*, after the beginning of September, retting becomes very much slower. In October the process is not likely to take less than a month, and at a later date it might easily occupy six weeks or two months. The retting or rotting is due to bacterial agency, and the optimum temperature for the fermentation appears to be from 90° to 95° F. It has been found that the activity of the organisms can be considerably increased by the addition to the retting water of certain salts.

The lower portion of the jute stem, being older and harder, is, of course, more difficult to ret than the upper, more succulent part. If, therefore, the whole of the stem is immersed at once, the upper part rets before the process in the lower bark is complete, with the result that "rooty" jute is obtained. If the plant has stood in water for a considerable time, the immersed portion of the bark sends out adventitious roots and becomes still tougher. The retting process is thus made even more difficult. In such a case, moreover, the fibre from the immersed portion of the plant becomes markedly coarser. Even retting over the whole length of the plant can be obtained by placing the bundles in an erect position in about 2 ft. of water for three or four days previous to their complete immersion. In this way the lower bark commences to soften before retting has begun in the upper portion. If the retted fibre is "rooty" the coarse lower portion can be cut off, leaving the upper portion for finer work. Sometimes, however, in the case of jute growing on immersed land there is a sudden temporary rise in the river, followed by a fall. In this case the middle—temporarily immersed—portion begins to harden to a greater extent than either the upper or the permanently immersed lower portion of the stem, and the result is a band of imperfectly retted fibre right in the middle of the strand. This is the worst aspect of rooty jute. It is known in the trade as "middle root."

When the retting is complete the bundles of jute are taken out of the water. It is found that the bark, which, of course, contains the fibre, has become quite soft and can easily be separated from the central pith. Moreover, the parenchymatous tissue in which the fibre is embedded, as in a ribbon, has been so softened and dissolved away that, after stripping from the stem, the fibre only needs careful washing and drying to be ready for the market.

Regarding the yield of fibre to be expected from jute, everything depends upon the conditions under which the crop is grown. On first-class land in a favourable season a return of over 30 maunds (say 6 bales) per acre, though exceptional, is not impossible. A 20 maund crop (4 bales) is comparatively common. On the other hand, under adverse conditions, the average yield over large tracts frequently falls to from 10 to 12 maunds per acre (say 2 to 2½ bales), or even less.

On the whole the Government standard of 15 maunds (3 bales) per acre seems to be a fair approximation to an average yield for the whole of the jute-growing tract; but it should be carefully noted that this figure is not intended in any way to convey the idea that wide variations from it are not very common.

There are two main varieties of the jute plant in common cultivation in Bengal, viz.:—

(*a*) *Corchorus olitorius* (long-fruited jute), which is locally known under the following vernacular names: *baugi pat* (Dacca), *tosha* (Pabna), *satnalla* (Faridpur), *deo pat* (Dacca and Tipperah), *desi pat* (Hooghly), *mita pat* (Assam and Orissa).

(*b*) *Corchorus capsularis* (round-fruited jute), *deswal* or *kakya bombai* (Pabna), *baren, bara pat, chota pat, aussa* (Mymensingh), *belgachi, dhaleswari* (Dacca), *bhadya, hewti, bitri* (Rangpur and Jalpaiguri), *amon, aussa* (Faridpur), *deodhali* (Tipperah), *tita pat* (Assam and Orissa).

*C. olitorius* is more commonly cultivated in the districts surrounding Calcutta, such as Hooghly, Jessore, etc. It is also very common to the north of Calcutta as far as Goalundo, in Rajshahi, and in parts of Pabna. Its cultivation is on the increase also on the high land in the Dacca district. It produces a strong, rather coarse fibre which is commercially known as desi jute. It is a heavy yielder, but the value of its fibre has hitherto been consistently less than that of *C. capsularis*. In recent years, however, there has been a tendency towards a better appreciation of the qualities of desi jute, the result of which has been a corresponding tendency towards an equalization of prices. *C. olitorius* does not thrive so well as *C. capsularis* on lands which become deeply submerged. Its cultivation is therefore likely to be restricted to the higher jute-growing tracts. Under these conditions, besides the fact that it is a heavy yielder, it has an advantage over *C. capsularis* in that it can be sown considerably later without prejudicing its prospect as a crop. This is a very important matter in the more westerly districts of Bengal, for instance, where rainfall is often so late that the chances of a successful crop of *C. capsularis* would be problematical.

*C. capsularis* is more widely grown than *C. olitorius*. It is practically the only kind of jute to be found in the Jalpaiguri, Rangpur, Mymensingh, and Purnea districts, and by far the larger area in the Dacca and Tipperah districts is also sown with *C. capsularis*. It yields a finer, softer fibre than *C. olitorius*, and once it has reached a height of about 5 ft. it will continue to grow unchecked even when the land becomes deeply submerged.

Other differences between *C. capsularis* and *C. olitorius* are:—

(*a*) The seed of *C. capsularis* is red and rather larger than that of *C. olitorius*, which has a greenish-black colour.

(*b*) Both flowers are yellow in colour; but that of *C. olitorius* is twice as large as that of *C. capsularis*.

(*c*) The leaves of *C. olitorius* are sweet to the taste (*mita pat*), and are commonly used as a vegetable. The leaves and seeds of *C. capsularis*, on the other hand, are bitter (*tita pat*), and an infusion of the dried leaves is commonly used in Bengal as a tonic medicine. A considerable quantity of the crude bitter principle has recently been isolated by the Fibre Expert to the Government of Bengal, and its physiological action is now being investigated in England, as well as by the Indian Foods and Drugs Committee.

A detailed study of the crops of *C. capsularis* found in different districts has shown that the species embraces a number of different types. All these types possess the same general characters, viz.:—

(*a*) Small yellow flowers.
(*b*) Round fruits.
(*c*) Reddish-brown seeds.

Yet they differ among themselves as regards tallness, time of ripening, colour of stem, etc. Some kinds, for instance, grow to a height of 9 to 10 ft., while others, under the same conditions, only reach 7 to 8 ft. It has been noticed that, as a rule, the former ripen later than the latter, there being a month or more between the earliest and latest races. In colour of stem a large number of intermediate types between purple, red, and pure green have been found, including one whose stem is green, but whose leaf petioles are red. After careful elimination of identical types about twenty races of *C. capsularis* remain which show more or less marked individuality, either in colour of stem or in time of ripening.

Recent work by Mr. Burkill and myself has shown that intermediate colour types between red and green are probably due to chance hybridization; nevertheless, self-fertilization takes place under ordinary circumstances to the extent of about 98 per cent. This is equivalent to saying that the seed of a jute plant almost invariably produces plants similar to the parents. It follows, therefore, that a superior race of jute would, given ordinary precautions, not be in greater danger of being swamped by adjacent inferior races. It follows also, on the other hand, that by judicious selection the cultivator can easily obtain a pure strain of any type of jute in his field which he may prefer.

Early green races of jute are extensively cultivated in the following districts:—

Purnea,
Jalpaiguri,
Rangpur,
Mymensingh (Jamalpur).
Dinajpur.

While early red races are common in:—

Jalpaiguri,
Rangpur,
Mymensingh (Sarisabari).

It appears that early, and usually smaller, races are chiefly, if not entirely, grown in the Northern districts. In these tracts, moreover, few very late races are to be found. On the other hand, while practically no very early races are grown in the more southerly districts, the latest races of all are commonly cultivated here. In Pabna, Dacca, Tipperah, and Faridpur, for instance, a large proportion of the jute is very late, and even so-called *aus* crops are comparatively much later than the early races of the northerly districts.

Somewhat similar differences as regards colour and the time of ripening are to be found among the races of *C. olitorius;* but in this case the cultivation of both early and later races is confined to the Southern districts. Very little *C. olitorius* is grown north of Sirajganj.

Recent investigation by the writer has indicated considerable differences in the quality of the fibre yielded by different plants of jute. These differences appear to be an intrinsic property of the plant, though the quality of the fibre of all plants also seems to be subject to certain fluctuations due to the effect of environment. Using this property as the basis of selection, it has been found possible to obtain pure cultures of jute which appear to show an average improvement of 10 per cent., and in some cases of nearly 20 per cent., over the average for the parent race from which the original single plant selection was made. The demand for really superior jute fibre appears to be somewhat limited, but the method of selection seems to be of general application, and it may possibly be of considerable use in improving other fibres the quality of which is of more importance than is the case with jute.

The prepared jute fibre may enter the market in one of several ways. In the early days of the jute trade it was common for the ryot to bring his produce to a large centre and there sell it direct to a big dealer. Nowadays the ryot seldom comes farther than the various country centres or *hats*, where he sells to the *bepari*, or native dealer. In a large number of cases a small dealer called a *faria* travels from village to village buying up small quantities of jute, which he ultimately takes by boat, if possible, into the nearest country market. Here he meets both the *bepari*, or native dealer, and also in recent years the representatives of large European farms. Formerly the *bepari* used to have the smaller country markets to himself, and jute was collected by him at these markets to sell to the big baling firms at large centres. In some cases, indeed, large firms were in the habit of advancing very considerable sums of money to the *bepari* to purchase jute on their behalf. In recent years, as has already been remarked, European baling firms at large centres have found it to their advantage to form their own buying agencies at small country markets, where they compete with the *bepari* in buying from the *farias*. Their purchases are, if possible, placed in country boats and towed by launches to headquarters, where the jute is sorted into a number of qualities, usually designated Nos. 1, 2, 3, 4, and "rejections," and then baled.

The chief of the large centres for the purchase of jute are Narainganj, Chandpur, Madaripur, Sirajganj, Jagannathganj, Demah, Jalpaiguri, Purnea, Kushtia, Goalundo, etc. Of these Narainganj, which deals with nearly 25 per cent. of the total jute crop, is by far the most important. It is ideally situated on a fine broad river, whose banks are lined for a long distance on either side with jute warehouses. In the middle of the jute season the river is a very busy highway navigated by large numbers of craft, from the largest river steamers and huge flats to the smallest country boats, and the whole scene is amply sufficient evidence, if such were needed, of the magnitude and importance of the premier industry of Bengal.

In a large centre like Narainganj some firms deal only with Calcutta, while others bale for export also. The former commonly use a small press, producing a 3 to 3½ maund bale. For export the standard 5 maund (400 lb.) bale is universal. Of the jute which goes into Calcutta, the greater proportion ultimately finds its way to the Calcutta jute mills; but a large quantity is also rebaled after sorting for export. Each exporting firm has one or more "marks" or standards of quality, and the sorting is done with this object in view. Thus, although the jute may have been sorted already up country, the standard of the up-country dealer does not always agree with that of the particular "mark" for which the Calcutta export baler is known, necessitating a readjustment of quality. It should be said that the "root" already referred to in describing the preparation of jute is cut off before baling. In this state it is known in the trade as "jute cuttings." Shortness in the supply of raw material, aided by improved preparing machinery, is causing an increasingly large use in the mills of what used to be disposed of as "cuttings and rejections." The balance is exported for the manufacture of paper.

The increase in the number of jute press houses has been considerable in recent years, both in the neighbourhood of Calcutta and in the mofussil, as the following figures show:—

TABLE II.

STATEMENT SHOWING THE NUMBER OF JUTE PRESSES FROM 1891-1910 INCLUSIVE.

| Year | Calcutta, including Howrah and 24 Parganas | Bengal, excluding Howrah and 24 Parganas | Total for Bengal | Eastern Bengal |
|---|---|---|---|---|
| 1891 | 18 | — | 18 | 9 |
| 1901 | 19 | — | 19 | 64 |
| 1902 | 19 | 5 | 24 | 72 |
| 1903 | 20 | 2 | 22 | 71 |
| 1904 | 20 | 2 | 22 | 75 |
| 1905 | 20 | 2 | 22 | 94 |
| 1906 | 20 | 3 | 23 | 101 |
| 1907 | 25 | 5 | 30 | 127 |
| 1908 | 27 | 4 | 31 | 121 |
| 1909 | 29 | 7 | 36 | 136 |
| 1910 | 35 | 7 | 42 | 124 |

It is clear from these figures that the number of press houses has more than doubled in the last ten years. The increase is very large in the mofussil, especially in Eastern Bengal, where small presses pressing from 1 to 3 maunds are often encountered in the most out-of-the-way places. Considering the convenience with which baled jute can be handled as compared with the loose fibre, the popularity of the baling press is not to be wondered at.

The total estimated area under jute in 1901-02 was given as 2,339,100 acres, and the out-turn as 7,000,000 bales. Table III gives the estimated acreage in each of the years 1902-12 inclusive, together with the out-turn, according to trade statistics. The figures show that there has been a very considerable increase in acreage—approaching 50 per cent. in the course of the last

## TABLE III.

| Year | | Acreage under jute | | Out-turn in bales of 400 lb. | | Value in rupees * |
|---|---|---|---|---|---|---|
| 1902-03 | ... | 2,200,000 | ... | 6,577,000 | ... | 183,370,950 |
| 1903-04 | ... | 2,500,000 | ... | 7,241,000 | ... | 165,196,884 |
| 1904-05 | ... | 2,850,000 | ... | 7,191,000 | ... | 188,844,274 |
| 1905-06 | ... | 3,145,000 | ... | 7,948,000 | ... | 192,084,594 |
| 1906-07 | ... | 3,482,000 | ... | 8,569,000 | ... | 256,814,231 |
| 1907-08 | ... | 3,974,300 | ... | 8,648,000 | ... | 393,971,676 |
| 1908-09 | ... | 2,856,700 | ... | 8,780,000 | ... | 366,074,646 |
| 1909-10 | ... | 2,876,600 | ... | 9,096,000 | ... | 243,620,617 |
| 1910-11 | ... | 2,937,800 | ... | 8,124,000 | ... | 253,096,200 |
| 1911-12 | ... | 3,106,400 | ... | 9,500,000 | approx. | 281,000,000 |
| 1912-13 | ... | 3,353,841 | ... | 10,005,000 | ,, | 368,000,000 |

* The figures of value are based on the wholesale price of jute at Calcutta in each year.

decade—and the same is roughly true as regards the out-turn.

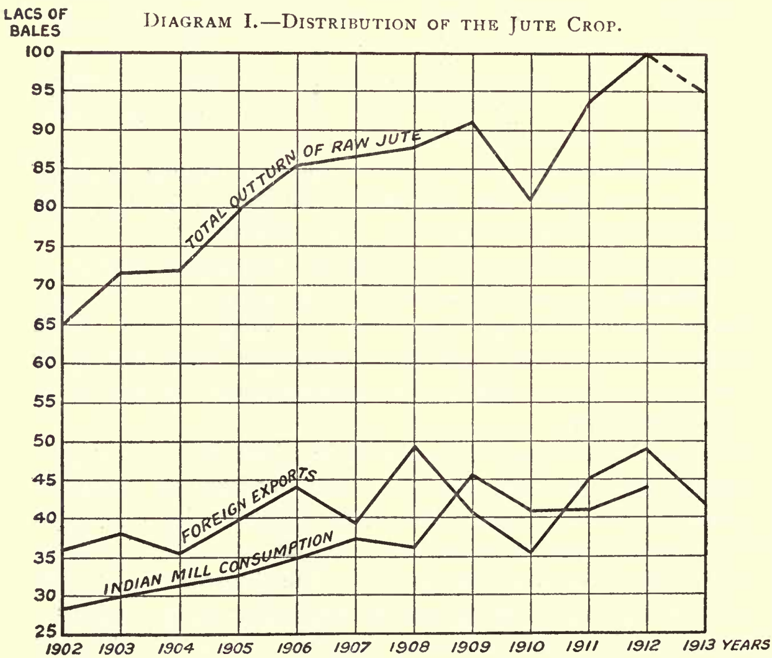
In Table IV will be found the figures for:—

(*a*) Jute consumed by Indian mills and its value.

(*b*) The amount of jute exported from various ports in Bengal, etc., and its value.

The contents of Table IV are depicted in graphic form in the curves in Diagram No. 1. A study of these data

DIAGRAM I.—DISTRIBUTION OF THE JUTE CROP.



## TABLE IV.

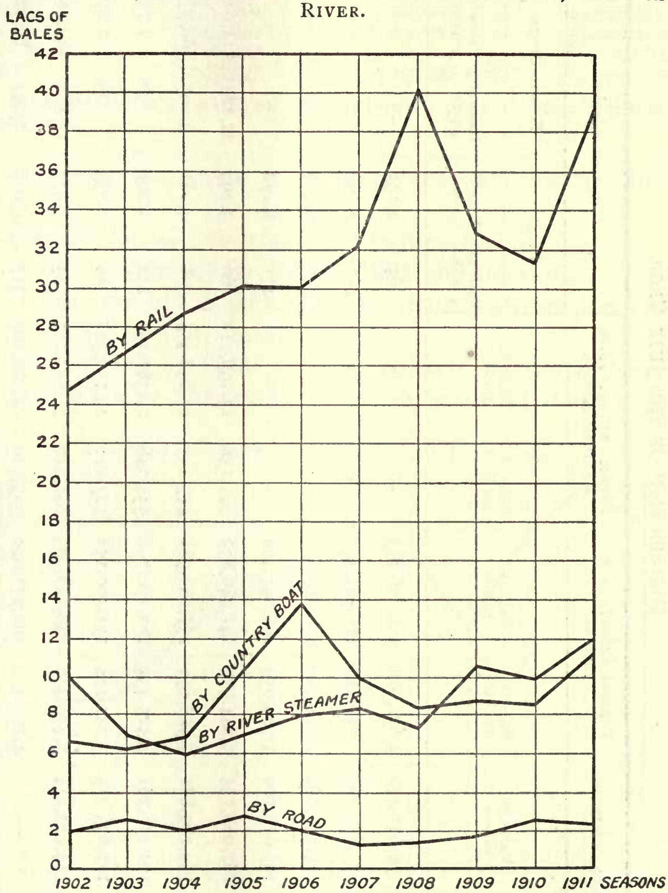
### DISTRIBUTION OF THE JUTE CROP.

| | INDIAN MILL CONSUMPTION | | FOREIGN EXPORTS FROM BENGAL | | FOREIGN EXPORTS FROM EASTERN BENGAL | | COASTING EXPORTS | | | | TOTAL EXPORTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Bengal | | Eastern Bengal | | | |
| | Bales of 400 lb. | Value in rupees | Bales of 400 lb. | Value in rupees | Bales of 400 lb. | Value in rupees | Bales of 400 lb. | Value in rupees | Bales of 400 lb. | Value in rupees | Bales of 400 lb. | Value in rupees |
| 1902-03 | 2,824,000 | 70,931,428 | 3,632,022 | 110,826,173 | — | — | 64 | 2,135 | — | — | 3,632,086 | 110,828,308 |
| 1903-04 | 2,975,000 | 77,587,587 | 3,819,247 | 116,591,447 | — | — | 150 | 4,868 | — | — | 3,819,397 | 116,596,315 |
| 1904-05 | 3,165,000 | 84,542,865 | 3,555,300 | 118,261,045 | — | — | 230 | 8,319 | — | — | 3,555,530 | 118,269,364 |
| 1905-06 | 3,312,000 | 107,016,700 | 3,986,059 | 168,654,428 | — | — | 231 | 8,172 | — | — | 3,986,290 | 168,662,600 |
| 1906-07 | 3,524,000 | 162,020,794 | 3,944,977 | 241,249,833 | 443,138 | 23,195,712 | 66 | 3,293 | 21,188 | 811,628 | 4,409,369 | 265,260,466 |
| 1907-08 | 3,763,000 | 159,289,881 | 3,528,654 | 157,083,981 | 417,233 | 21,638,353 | 98 | 4,181 | 3,165 | 160,733 | 3,949,150 | 178,887,248 |
| 1908-09 | 3,650,000 | 101,277,361 | 4,425,434 | 168,190,792 | 554,348 | 29,387,183 | 122 | 5,296 | 30 | 1,790 | 4,979,934 | 197,585,061 |
| 1909-10 | 4,587,000 | 127,633,275 | 3,741,174 | 131,100,198 | 327,218 | 19,130,382 | 80 | 2,733 | 25 | 1,270 | 4,068,498 | 150,234,583 |
| 1910-11 | 4,093,000 | 114,922,344 | 3,256,400 | 136,142,903 | 291,550 | 18,083,163 | 85 | 3,953 | 13,864 | 594,180 | 3,561,899 | 154,824,199 |
| 1911-12 | 4,107,000 | — | 4,126,433 | 199,931,620 | 393,526 | 24,882,101 | 317 | 14,910 | 1,444 | 80,225 | 4,521,720 | 224,908,856 |

shows very clearly the progress which has been made by Indian mills in the last ten years in the matter of the consumption of jute.

Table V shows how the jute crop is brought into Calcutta, and Diagram No. 2 shows the position still more

DIAGRAM II.—JUTE IMPORTED INTO CALCUTTA BY RAIL, ROAD AND RIVER.




clearly. It would appear that almost the whole of the increased produce of jute in the last ten years has been brought to Calcutta by train, and that the respective amounts brought in by other methods of transport have remained substantially constant.

## TABLE V.

Statement showing the Quantity and Value of Jute Imported into Calcutta by Rail, Road and River during the Years 1902-03 to 1911-12 inclusive.

| Year | By rail | | By road | | By boat | | By steamer | |
|---|---|---|---|---|---|---|---|---|
| | Quantity | Value | Quantity | Value | Quantity | Value | Quantity | Value |
| | Maunds | Rupees | Maunds | Rupees | Maunds | Rupees | Maunds | Rupees |
| 1902-03 | 12,252,021 | 60,273,759 | 1,054,234 | 5,051,538 | 3.330,644 | 16,236,889 | 5,011,962 | 24,394,718 |
| 1903-04 | 13,278,208 | 67,150,127 | 1,303,562 | 6,575,914 | 3,172,645 | 14,429,527 | 3,487,506 | 19,181,283 |
| 1904-05 | 14,328,323 | 77,253,048 | 1,0 8,871 | 6,008,054 | 3,425,751 | 18,841,630 | 3,007,574 | 16,399,259 |
| 1905-06 | 15,226,743 | 119,929,375 | 1,475,843 | 11,683,460 | 5,259,661 | 41,748,558 | 3,547,520 | 28,208,725 |
| 1906-07 | 15,070,838 | 138,939,711 | 1,100,877 | 10,500,860 | 6,950,660 | 64,293,605 | 4,122,650 | 38,440,330 |
| 1907-08 | 16,169,365 | 111,310,602 | 695,814 | 4,955,931 | 4,858,78[illegible] | 32,796,765 | 4,252,101 | 28,815,364 |
| 1908-09 | 20,211,100 | 114,262,881 | 733,313 | 4,650,488 | 4,267,550 | 25,338,578 | 3,796,983 | 21,801,297 |
| 1909-10 | 16,396,595 | 85,763,819 | 934,148 | 5,276,684 | 4,404,084 | 22,766,507 | 5.360,611 | 28,143,108 |
| 1910-11 | 14,544,658 | 88,002,872 | 1,245,806 | 6,050,374 | 4,295,729 | 24,053,947 | 5 019,002 | 32,422,565 |
| 1911-12 | 19,660,782 | 128,310,113 | 1,231,890 | 7,224,918 | 5,665,388 | 34,933,823 | 6,061,565 | 37,127,086 |

The importance of the jute mill industry of Bengal has already been referred to in dealing with the distribution of the crop.

Table VI gives statistics regarding the mills.

TABLE VI.

| Year | Districts in which mills are situated | | | | Total number of mills | Number of looms | Number of spindles | Number of hands employed |
|---|---|---|---|---|---|---|---|---|
| | 24 Parganas | Howrah | Hooghly | Chandernagore | | | | |
| 1891 | 24 | — | — | — | 24 | 8,814 | 177,718 | — |
| 1901 | 20 | 9 | 5 | — | 34 | 15,336 | 313,740 | — |
| 1910 | 26 | 11 | 7 | 1 | 45 | 32,944 | 676,758 | 204,104 |

The total amount of share capital and debentures invested in these mills now amounts to about 15 crores of rupees, or £10,000,000. The capital is largely European. As has already been stated, the mills consume about half of the total jute crop, or about 40 lacs of bales. To supply the necessary power, over 617,000 tons of coal are annually required.

In the period 1903-10 the number of looms in Calcutta mills increased by over 85 per cent. As there was also an extension in foreign plant, and as the rate of production of the raw fibre did not increase to the same extent, there was increased competition amongst mills for the fibre, resulting in a considerable enhancement in the price of the raw material. So long as the demand for manufactured goods was keen all was well; but in a period of depression in the year 1908-09 there was a tendency to over-production, and it was necessary to restrict the time of working to five days per week in consequence. Later, in the latter half of 1910, the demand for jute goods again asserted itself, and at the present time it is so great that, although last year's crop was probably a record one, it has been almost completely consumed at practically famine prices, and the mills are now said to be in a more favourable position than they have been for years.

It is impossible in this note to give any description of the processes through which jute goes in the course of manufacture, but it should be said that a visit to one of the forty Calcutta jute mills is advisable to anyone in search of an object-lesson regarding the modern developments of industry in India. Not only is electricity the only lighting agent, but the thousands of horse-power required to drive the maze of machinery is also applied as electricity, which is produced by dynamos driven by turbine engines of the most modern pattern. Nevertheless, the Calcutta mills up to the present have confined themselves to the production of the coarser classes of goods, chiefly gunny bags and Hessian cloth. In Dundee, on the other hand, a large proportion of work of much finer quality is done. Jute now enters into the composition of material for cheap clothing. It is also largely used for the manufacture of carpets, curtains, etc. Its capacity of taking dyes well is a great advantage in work of this kind.

The countries to which the chief foreign exports of raw jute are made are:—

United Kingdom,
Germany,
France,
United States,
Austria-Hungary.

Of these the imports of the European countries consist chiefly of the better qualities of fibre; the exports to America are said to consist largely of "cuttings" and "rejections" destined for the manufacture of paper.

The Indian manufactured goods consist chiefly of gunny bags, gunny cloth, and a small and apparently decreasing amount of twine. The latter is doubtless being ousted by material of better quality made from one of the other hemps whose production has increased so largely in recent years.

The chief points to which gunny bags are exported are:—

| | | |
|---|---|---|
| (*a*) British Empire ... ... ... ... | | 170,000,000 bags |
| Including: Australia ... ... | 69,748,000 bags | |
| United Kingdom ... | 33,527,000 ,, | |
| Straits Settlements and Hong Kong ... | 21,000,000 ,, | |
| South Africa ... | 13,000,000 ,, | |
| Egypt ... ... | 12,000,000 ,, | |
| New Zealand ... | 8,000,000 ,, | |

| | | | |
|---|---|---|---|
| (*b*) Foreign ports ... | | | 190,000,000 bags |
| Including: | United States | 36,000,000 bags | |
| | Siam | 13,000,000 ,, | |
| | Indo-China | 14,000,000 ,, | |
| | Java | 11,000,000 ,, | |
| | West Indies | 10,000,000 ,, | |
| | Turkey (Europe and Asia) | 9,500,000 ,, | |
| | Germany | 6,500,000 ,, | |
| | Belgium | 6,500,000 ,, | |

The United States and the Argentine alone take nearly 86 per cent. of the total production of gunny cloth from India, as the following figures show:—

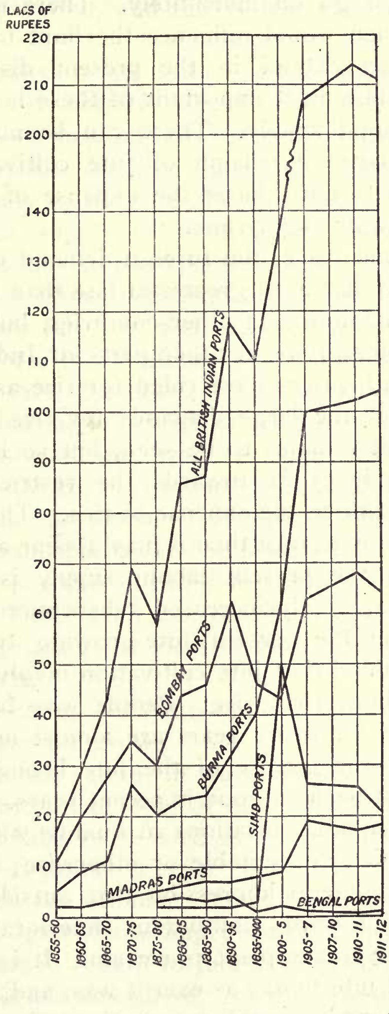
| | | | |
|---|---|---|---|
| (*a*) British Empire ... | | | 100,000,000 yd. |
| (*b*) Foreign ports... | | | 854,503,000 ,, |
| Including: | United States of America | 662,534,000 yd. | |
| | Argentina ... | 161,916,000 ,, | |

Generally it may be stated that, excepting the United Kingdom, Hong Kong, and perhaps the Straits Settlements, which are redistributing centres, the bulk of the jute manufactures go to countries which are engaged in producing large quantities of agricultural products, such as the United States, Argentina, Australia, the West Indies, Sandwich Islands, and Mauritius. Chile and Peru, on the other hand, use large numbers of gunny bags for the export of the produce of their nitre beds. Of all the countries in the world, the United States is much the largest consumer of Indian jute manufactures. The value of India's exports to the United States has risen from about Rs. 25 lacs in 1885 to about Rs. 6 crores in 1910-11. The total value of exported Indian jute manufactures approximates to 17 crores of rupees—say, £11,000,000 sterling. In 1874-75 the foreign export trade was only worth Rs. 22 lacs.

The Indian coasting trade in jute manufactures, though much smaller in volume and also increasing more slowly than the foreign export trade, is nevertheless one of great importance. Diagram No. 3 is interesting in this connection as illustrating the progress of the Indian coasting trade since 1855. The diagram is based on the one contained in the lucid report on the maritime trade of Bengal for 1906-07 by Mr. L. F. Morshead, I.C.S. It is only altered to bring it up to date from the time at which it was published.

While dealing with statistics of the jute crop, it is

DIAGRAM III. (AFTER MORSHEAD).—EXPORTS OF JUTE MANUFACTURES FROM CALCUTTA TO INDIAN PORTS.




convenient to consider how far the present jute-producing area is approaching its limits. There has in recent years been a very large increase in the actual acreage under jute, but there has not been a corresponding expansion in the tract of country over which jute is produced. In other words, nearly all the districts which now produce jute did so years ago, only on a much smaller scale. In recent years, therefore, the proportion of jute to other crops in these areas has increased considerably, but the process cannot go on indefinitely. There is more than one point which would influence the limit to which jute cultivation can extend in the present districts which produce it. The most important of these is undoubtedly that of the food supply. There can be no doubt that any further large extension of jute cultivation in the present districts must be at the expense of food crops, such as paddy or sugar-cane.

In the second place, the foreign demand on India and Burma for rice has been greater of late than usual, partly on account of famines in other countries, but partly also on account of scarcity in other parts of India, with the result that high prices have ruled for rice as well as for jute. Whether the large demands for rice will be permanent or not remains to be seen, but so long as they last their tendency is towards the restriction of the cultivation of jute at the expense of rice. The third point is of greater importance than it may appear at first sight, viz., how far the present labour supply is capable of dealing with a largely increased substitution of jute for other crops in the present jute-growing tracts, for it cannot be doubted that jute cultivation involves considerably more labour than rice. People who have been in the jute trade for many years are almost unanimous in believing that the quality of the jute brought into the market has not been so good in recent years. Of course, there are spasmodic variations in quality which are due to seasons which are suitable or otherwise; but there is a strong and general impression that outside this there is a tendency towards continuous deterioration. That this is not due to the plant is certain. It is possible to grow as good jute to-day as ever it was, and, given good retting water and careful preparation, the results are entirely satisfactory. It is certainly a crop which demands considerably more labour than rice, and the reaping and preparation of the fibre is one of the most exacting stages in its production. If, therefore, the cultivator is coming to a stage when he tries to cultivate more jute than he can conveniently manage, one of the first signs will be a tendency towards more and more careless preparation, and this is just what appears to be happening.

This difficulty is to some extent mitigated by the employment of outside labour, for every year large numbers of coolies migrate eastwards from the over-crowded districts of Bihar and the United Provinces, more especially to the jute-growing districts of Northern Bengal. The supply of such labour, however, is not only limited, but it is expensive and, through lack of experience, is often inefficient. The rise in the cost of production of jute, as well as a deterioration in the quality of fibre, is therefore not prevented.

There appears, therefore, to be some reason for the contention that, as far as actual acreage is concerned, the present jute-producing tract is approaching its limit. There is certainly no ground, on the other hand, for believing that the demand for jute is likely to slacken more than temporarily, and it behoves us, therefore, to examine the position in order to see how this demand is to be met. There are three possible ways, viz.:—

(1) By improving the yield of fibre in the present jute-producing area.

(2) By extending the cultivation of jute to tracts where it is not at present grown.

(3) By the cultivation, in tracts which are not suitable for the production of jute, of other plants whose fibre is sufficiently similar to be used as a substitute for jute.

Taking these points in order: (1) There can be no doubt that as far as the ultimate, if not the immediate, future is concerned agricultural improvement is destined to play as great a part in regard to jute as it has done with other crops in India and elsewhere. In the case of jute, careful plant to plant selection has already placed in our hands races, the yield and quality of which are both considerably better than the average. The seed of these improved races has been multiplied, and seed farms are now being established to produce seed on a very large scale for distribution to cultivators. Other work of the Agricultural Department points, as it was bound to, to considerably enhanced yields, not only of jute but of other crops, by means of improved methods of cultivation and manuring. It is obvious, therefore, that agricultural improvement alone contains the prospect of a largely increased total output of jute, amounting possibly to from 15 to 20 lacs of bales; but although the ultimate effect of the dissemination of this information to the cultivator will be great, the progress at the commencement seems very slow, for not only are the cultivators intensely conservative, but their number is very great, their holdings are small, and they are spread over an area as large as Great Britain. The development of the system of Cooperative Credit Societies is of great importance in this respect.

(2) Regarding new areas in which jute cultivation could extend: The natural outlet would, of course, be the plains of Assam, which are by reason of the prevailing conditions of soil and climate peculiarly fitted for jute cultivation. There is, indeed, little doubt that this tract is capable of supporting at least another million acres of jute without unduly straining the proportion between jute and other crops. The lack of population in much the greater part of Assam is, however, an almost insuperable bar in the way of any rapid extension, and, although numbers of Bengalis from the crowded Southern districts are beginning to emigrate to Assam, it would appear that by nothing short of a wholesale colonization scheme can progress be otherwise than very slow.

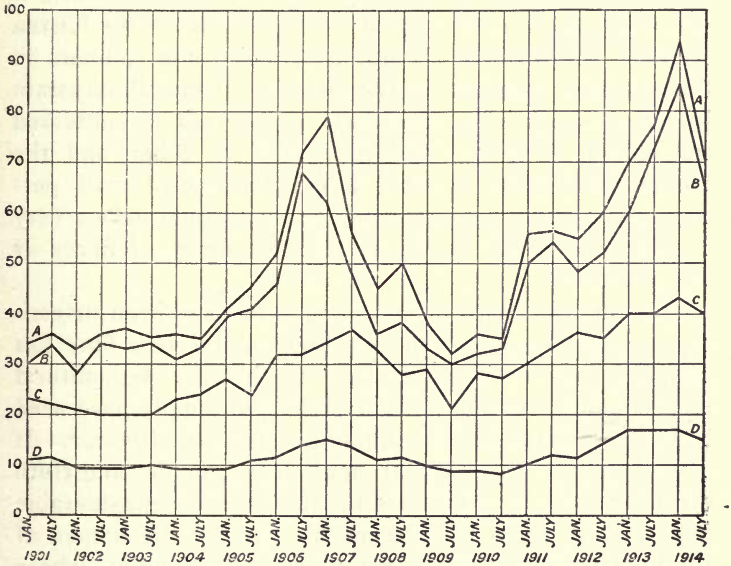
In Bihar, Purnea is a very large jute-producing centre, but Cuttack is the only other district which grows more than 10,000 acres of jute. High prices in the years 1905-06 (*see* Diagram No. 4) caused about 10,000 acres of jute to be grown in 1907-08 in the districts of Mozufferpore and Champaran, but the area fell again later, partly owing to lower prices, and partly to lack of market facilities. There has been a steady increase during the last three years, and there is every prospect that this tract will ultimately produce jute on a considerable scale.

Experimental jute has been grown with success in most parts of India, and big crops have been produced in the irrigated tracts of the Punjab, the Central Provinces, and Madras. In all these places, however, the

Diagram IV.—Prices (in Rupees) of Raw and Manufactured Jute in the Period 1901-1914.

*References :*

A = Jute | C.C. | raw per bale of 400 lb.
B = Jute ordinary per bale of 400 lb.
C = Gunnies, No. 2 Twill, 44 in. × 26½ in., per 100.
D = Hessian cloth, 10½ oz., 40 in., per 100 yds.




circumstances are more difficult for jute than in Bengal, and it is hardly likely that, as things are at present, jute cultivation would be taken up on any large scale outside Bengal, Bihar, and Assam.

(3) In these circumstances the question of jute substitutes is one of considerable interest. There would be no object, of course, in introducing such a substitute

35

into Bengal, which is the home of jute. There are, however, two fibre plants to be met with in cultivation in nearly every part of India. Of these, *Hibiscus cannabinus* produces a fibre which is very similar in many respects to jute, although, naturally enough, it is not looked upon with favour in Calcutta. It is, nevertheless, especially certain varieties of it, a stronger, and probably a more durable fibre than jute, and for this reason alone, if for no other, its cultivation is worthy of encouragement. It is produced on a considerable scale in Madras, where there is a fluctuating area of between 50,000 and 80,000 acres in the East Coast districts. A gunny mill, whose annual consumption is said to be about 25,000 bales, has existed for many years at Bimlipatam, and it was proposed to erect another one at Ellore, in the Kistna district. It is worth noting, too, that some spinners in this country who are in the habit of using Bimlipatam jute also speak well of it. *H. cannabinus* is cultivated throughout Bombay, and especially in Bihar and the United Provinces, so that a comparatively small percentage increase over such a large area would have a very considerable effect on the aggregate supply of fibres of the jute class.

The different races of *H. cannabinus* have been investigated, and the seed of those producing the best fibre has been selected for multiplication, so that the Agricultural Department is now practically ready to supply pure seed of the best kinds in large quantities to the cultivator. It is important to observe that, apart from gunnies and cloth manufactured in Bimlipatam, there is a considerable export from India of hibiscus fibre under the names of Bimlipatam jute, Deccan hemp, etc., to London, where it is a recognized item in the market, and where it is bought for purposes for which jute would otherwise be required. The buyer of jute is thus relieved of a corresponding amount of competition. Any prolonged shortage in the supply of true jute is fairly certain to cause a considerable development in the cultivation of *H. cannabinus*.

We thus see that each of the three methods of increasing the supply of jute is capable of contributing its quota of help. Progress along new lines must necessarily be slow at the outset, but, taking all circumstances into consideration, every sign points to the fact that India will be able to supply the world with jute or similar fibres for a long time to come.

For the statistics contained in this paper I am glad to acknowledge my indebtedness to the late Mr. Noel-Paton, Director-General of Commercial Intelligence in India.

## THE FIBRE INDUSTRY IN MAURITIUS.

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The fibre industry is, after sugar, the most important agricultural industry of the Colony of Mauritius. The fibre is obtained almost entirely from forms of *Furcræa gigantea*, which are now to be found growing in practically all districts of the island. These plants were doubtless introduced into the island from the New World as ornamental plants, but the date of introduction is uncertain. They thrive exceptionally well, and spread rapidly by means of the numerous bulbils that are produced on the flower stems after flowering. Some exceptionally fine specimens of Furcræa plants are to be met with on the island. These are usually to be found on fertile lands at altitudes varying from 300 to 1,000 ft. On the upper, wetter, but cooler plateaux the plants do not generally attain such a fine development as at the lower altitudes, where the temperature is warmer. On the coastal regions, where rainfall is scanty, growth is often slow.

Fibre plants in Mauritius are locally called "aloes," and two varieties occur, viz., the "Creole Aloe" (*Furcræa gigantea* var. *Willemetiana*), and the "Aloe Malgache" (*Furcræa gigantea*).

The Creole aloes contain a larger percentage of fibre, and grow more rapidly than the aloes Malgache. In the higher altitudes the plants grow more slowly than in the warmer districts around the coast, and it is mainly in the coastal districts that exploitation of fibre takes place. The aloe Malgache grows much better than the Creole aloe at the higher altitudes, and those factories which obtain leaves from the higher lands often work quantities of the leaves of the former variety. Both varieties will grow on all the soils of the Colony, but the principal factors that appear to be necessary for satisfactory development are a uniformly high temperature combined with an adequate supply of water. If the temperature is low growth is slow, and if rainfall is scanty growth is stunted.

The Mauritius soils are comparatively fertile. They are characterized by a high percentage of iron salts with but little carbonate of lime. They may sometimes contain only small quantities of available potash and phosphates. Soils carrying aloes are generally in wild growth, and therefore do not as a rule show a marked shortage of available elements. The low percentage of calcium carbonate is often noticeable in soils of high fertility under intense culture, and it is conjectured that basic salts of iron may act as bases for biological action. Experiments to test this possibility are in operation.

The aloe Malgache, or *F. gigantea*, possesses a short woody trunk, which is crowned by 40 to 50 oblanceolate, rigidly coriaceous, subcarnose leaves. These leaves on vigorous plants are 4 to 7 ft. long, usually spineless, and of a bright bluish-green hue. From the plant a scape of 20 to 30 ft. in length arises, and forms in its upper half a loose panicle with greenish-white flowers about 2 in. broad. The ovary is cylindrical, the stamens are short, and the filaments strumose in the middle.

The Creole aloe, or *F. gigantea* var. *Willemetiana* is a Mauritian form of *gigantea*. It differs from the type form by possessing more spines along the lower portions of the leaf edges, by having a terminal spike to the leaf, and by possessing a well-defined constricted leaf base. The leaves are usually less pulpy than those of *F. gigantea*, and on the average shorter in length. The colour of the leaves of the Creole aloe is a yellowish-green.

It is estimated that there are approximately 20,000 arpents (1 arpent = 1·043 acre) under "aloes" in the

Colony. These are practically all self-sown, but it is estimated that some 1,500 arpents have been planted with the Creole variety.

*Plantations.*

Plantations of aloes date back about ten years. Small trials were at first made with Creole aloes, and as these gave fairly satisfactory results further plantations were undertaken. During 1905-10 plantings of sisal hemp (*Agave rigida* var. *sisalana*) were made for comparison with plantations of Creole aloes.

It is estimated that at the present time there are 60 to 75 arpents planted with sisal in the Colony. These plantations of sisal have grown satisfactorily, but in many cases growth has been irregular. They also require greater attention in the early stages than do plantations of Creole aloes. Sisal fibre prepared in the Colony has been found to be of good quality, and the small quantities placed on the European markets have commanded satisfactory prices.

On some estates areas of Creole aloes are planted yearly, so that young plantations are coming into bearing regularly. This policy has been found to be a wise one, and better results are being obtained than when wild growth is solely depended upon for supplies. Opinions differ as to whether plantings should be made with or without shade. Plantings made under the shade of filao trees (*Casuarina equisetifolia*) have been very satisfactory, while many plantations are allowed to become sooner or later overgrown with wild acacia (*Leucæna glauca*). Leaves grown under shade are not of such a thick and tough texture as leaves grown in full sunlight, and it is thought that they can be more easily dealt with in the factories. Casuarina is also of value as fuel, and acacia seeds are collected annually for cattle food.

For planting, bulbils which have fallen and rooted satisfactorily, or fair-sized suckers removed from their "mother" plants, are employed. Plants which have leaves 12 to 18 in. in length (*i.e.*, are about eighteen months old) are generally preferred, as they appear to stand transplanting well, and come to maturity quicker than smaller plants. There is a slight preference for suckers over bulbil plants, as it is thought that they transplant more satisfactorily. Aloes planted with eighteen-month suckers are first reaped between the third and fourth years after planting. The following details taken from the *Annual Report of the Chamber of Agriculture* for 1912 are of interest.

The then President (Mr. E. Carcenac) writes: "In large areas of the Black River district, for example, where the culture of sugar-cane, impossible without irrigation, is limited, the exploitation of aloes offers great possibilities."

After discussing probable costs of plantations, he states:—

"(1) Plants possessing leaves at least 18 in. long should be put in at the end of the dry season.

"(2) The plants should be put out quincunx at 4⅓ ft. apart. An arpent would, therefore, hold about 2,500 plants.

"(3) The year after planting a light cleaning should be made in order to destroy plants and weeds providing too heavy a shade.

"(4) The leaves may be cut between the fourth and fifth years after planting, and a subsequent cutting after two wet seasons.

"Each plant will give at each cutting a minimum of 30 leaves, or 75,000 leaves per arpent. This should represent at least 1 ton of dry fibre, and as cuttings would be made every two years, an average of ½ ton of dry fibre per arpent could be reckoned on for each period of twelve months."

### *Cutting.*

The cutting of leaves is usually carried out by task work. The cutters are paid on the average at the rate of 10d. per 100 packets. The weight of the individual packets is not taken, but it is generally estimated that one packet of leaves contains from 10 to 15 leaves and produces 1 kilogram of green fibre. Actual weighings have been made at several factories with the following results:—

Number of leaves per packet: 8 to 18. Average, 12·6.

Weight per packet: 6·1 to 8·4 kilos. Average 7·8 kilos.

Green fibre produced per packet: 0·89 to 1·2 kilo. Average, 0·98 kilo.

Dry fibre produced per packet: 0·16 to 0·18 kilo. Average, 0·175 kilo.

The leaves vary greatly in size, and no attempt is made to grade leaves either in regard to maturity or to size. At the time of cutting the central shoot and three to five unfolded leaves are left, but instances occur where all leaves are cut with the exception of the central shoot. The wild aloes are usually so close together and overgrown with acacia and shrubby weeds that it is not possible only to cut mature leaves such as could be practised on clean plantations. The packets of leaves are transported to the roads of the estates and placed in heaps. They are then transported by ox-cart to the factory.

Re-cutting of aloes takes place usually two years after the previous cutting, though sometimes the intervening period is shorter. As a rule, however, two wet seasons occur between one cutting and the next. The number of leaves taken off at each cutting varies greatly with the district and with the age of the plants.

### *Yield of Fibre.*

From figures collected at various factories in the Colony, it appears that an average of 65,000 leaves of Creole aloes will produce 1 ton of dry fibre. This gives an average fibre recovery of nearly 2·3 per cent. on the weight of the leaves. It is difficult, however, to give definite figures, as the fibre content varies considerably with the district and with the season of the year. In the higher altitudes the moisture content of the leaves is higher and the percentage of fibre lower than in the lower altitudes, and in the wet season the moisture content of leaves is considerably higher than in the dry season. Actual tests made at three factories in the

Black River district in the dry season of 1913 gave the following results:—

| | | | |
|---|---|---|---|
| Factory 1. | Percentage of dry fibre | | = 2·64 |
| ,, 2. | ,, | ,, | = 2·53 |
| ,, 3. | ,, | ,, | = 2·38 |

Careful laboratory tests made by Mr. Boname (then Director of the Station Agronomique of Mauritius) in 1902 gave the following figures:—

TABLE I.

| | Aloes Malgache from 1,000 ft. | Creole aloes from 600 ft. |
|---|---|---|
| Weight of leaves, kilos. ... ... ... | 65 | 47 |
| ,, green fibre obtained, kilos. ... | 4·950 | 4·900 |
| ,, dry ,, ,, ... | 0·930 | 1·170 |
| Dry fibre, percentage of green fibre ... | 18·8 | 23·9 |
| Green fibre, percentage of leaves ... ... | 7·61 | 10·42 |
| Dry fibre, ,, ,, ... ... | 1·43 | 2·49 |

TABLE II.

| | Aloes Malgache from 1,000 ft. | Creole aloes from 1,000 ft. | Creole aloes from 600 ft. |
|---|---|---|---|
| Weight of leaves, kilos. ... ... | 57·5 | 27·5 | 13·75 |
| ,, green fibre obtained, kilos. | 4·700 | 2·870 | 1·650 |
| ,, dry ,, ,, | 0·955 | 0·602 | 0·365 |
| Dry fibre, percentage of green fibre | 20·3 | 21·0 | 22·1 |
| Green fibre, percentage of leaves ... | 8·2 | 10·4 | 12·0 |
| Dry fibre, ,, ,, ... | 1·66 | 2·19 | 2·65 |

From Table II the difference between the percentage of dry fibre in leaves from altitudes of 1,000 ft. and of 600 ft. is clearly shown. On the littoral, yields of 2·3 to 2·5 per cent. of dry fibre have been obtained in some factories, while individual yields from selected leaves have exceeded 2·5 per cent. in dry seasons.

In the Colony it is customary to express the yield of dry fibre obtained as a percentage on the weight of wet fibre; yields varying between 16 and 18 per cent. are generally obtained. This form of calculation has arisen from the fact that labourers at the hand machines are paid on the quantity of green fibre produced per day. The weight of the leaves coming into the factory is not known, but the weights of green fibre obtained by the different employés are carefully checked. The weights of dry fibre are known when baled, and therefore an estimate of the value of work being done can readily be obtained by calculating the percentage of dry fibre on the weight of the wet fibre.

*Factories.*

The fibre factories are small ones, their output ranging from 50 to 100 tons of dry fibre per annum, with an average annual output of about 55 tons. In 1913 there were forty-two factories in operation. Of these twenty-five were situated in the Black River district.

The fibre is scraped by machines locally known as grattes, which are capable of producing on the average $\frac{1}{10}$ ton of dry fibre per diem. They are similar in operation to the raspadors of Mexico, and are fed by hand. They differ from raspadors in that they contain a greater number of scutching blades, and are generally worked at a greater speed. They are manufactured in machine shops in the Colony, and cost from £14 to £18 each. They are worked in series, and driven by steam or suction gas engines or by water-power. Water-power is naturally the cheapest form of power, and on some properties there are two or three small factories at different levels, in order that the supply of water may be utilized more than once. Steam-power is relatively costly, but was utilized up to 1912 in those factories where water-power was not available. In that year steam-engines commenced to be replaced by suction gas plants, and considerable economies in fuel have resulted. The suction gas engines are small ones, with a brake horse-power ranging from 19 to 40. They have been installed up to the present with charcoal producers, but plants to take ordinary wood refuse have been indented for installation within the next few months. The average consumption of charcoal in the types of engines introduced into the Colony varies, mainly according to the grade of charcoal used, from 0·8 to 1 lb. of charcoal per h.p. per hour.

The feeding of the grattes by hand is a costly and laborious process, and efforts have been made to instal automatic feeding machines. Such a machine (McGregor's patent) has been improved by a local firm of engineers and installed in five factories. This machine consists essentially of an inclined feeding table extending to the mouth of the gratte. Leaves are placed on this inclined table, gripped in the jaws of the feeder, and fed into the gratte automatically. The green fibre is then pulled back and taken out of the jaws as they open. The basal portion of each leaf is left unscraped, and has to be cut off and discarded. For small plants where labour is difficult to obtain this machine can be advantageously employed. It requires to have close supervision, or otherwise cutting of fibre and loss of leaves may result. The loss of the basal stumps of the leaves is also considerable unless the feeder is satisfactorily adjusted. During 1913 two of these machines worked throughout the year and are reported to have given general satisfaction. Three other factories which had installed them did not work with them, however, as the proprietors were of opinion that the loss of fibre was greater than when hand power is employed, and that the dry fibre was not of such a high quality.

The Government have taken in hand the matter of machinery for fibre production, and are installing in the Black River district a New Corona Automatic Decorticating Machine with a view to ascertaining whether reductions in the cost of production can be effected.

### *Manufacture.*

The leaves are brought to the factories by tramways or by ox-carts. They are delivered to the factories in packets each containing from eight to eighteen leaves. These packets are then checked and placed in heaps, from which they are transported as required to the "gratteurs." Two gratteurs work at each gratte, and a table is installed for each gratteur. The leaves are placed on these tables, and are fed by the gratteurs into the machines two or three at a time. One half of the leaf is scraped and then withdrawn. The leaf is then turned and the other half fed into the machine. The green fibre, as scraped, is placed on rails which are placed alongside, and from there it is taken and tied into small bundles. The gratteurs are paid at the rate of 60 to 80 cents per 100 kilograms of green fibre. They work from four to six hours per day, and produce on the average 200 to 250 kilograms of green fibre per man. Two shifts per day work at each gratte when labour is available.

The green fibre, after having been tied in small bundles, is weighed and taken by women to the washing basins. It is thoroughly washed in clean water, and afterwards placed in a basin containing a soap solution, made by dissolving common soap in water at the rate of 5 to 10 kilograms of soap per 1,000 kilograms of green fibre. The green fibre is allowed to soak in this solution for thirty-six to forty-eight hours. The soap solution helps to disintegrate the particles of pulp attached to the fibre, and also helps to give a white colour to the fibre.

The fibre is removed from this solution and washed in clean water. Afterwards it is taken and suspended on wooden rails in the open air for bleaching and drying in the sun. The colour of the dry fibre depends largely on the weather conditions prevailing at the time of bleaching and drying. If the weather is sunny a white product results, but if it is overcast and damp a yellowish-brown fibre is often obtained.

From the driers the fibre is taken to the brushing machines, where the tow and attached particles of pulp are removed. Stained parts of the fibre are cut out, and it is then baled in sacking in bales of 200 to 250 kilograms each with hand baling presses. The fibre is graded according to the colour into "prime," "good," and "fair" grades.

These bales are then marked and sent to Port Louis. The fibre is purchased by a local firm at current rates and exported by them to London.

### *Cost of Production.*

In the *Annual Report of the President of the Chamber of Agriculture* for 1911 it is stated that the cost of production per ton of dry fibre approximated £11 15s. where water is employed, and £14 where steam is used. The

Royal Commissioners in 1908 obtained figures varying from £10 to £15 per ton.

The cost of production has been carefully inquired into during the past year. The figures vary in the different localities. If leaves are available near the factories the cost of transport is reduced, and if tramway systems exist the transport cost is less than where ox-carts have to be employed. The average cost of production per ton of dry fibre might be itemized as follows:—

| | Factory with water-power | | Factory with suction gas-power | | Factory with steam-power | |
|---|---|---|---|---|---|---|
| | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. | £ s. d. |
| Cutting ... | 2 5 0 | | 2 5 0 | | 2 5 0 | |
| Transport of leaves to factory | 1 5 0 | to 2 0 0 | 1 5 0 | to 2 0 0 | 1 5 0 | to 2 0 0 |
| Feeding leaves to gratteurs | 0 8 0 | | 0 8 0 | | 0 8 0 | |
| Decorticating ... | 2 13 4 | | 2 13 4 | | 2 13 4 | |
| Skins for gloves of gratteurs | 0 6 0 | | 0 6 0 | | 0 6 0 | |
| Removal of residue | 0 4 0 | | 0 4 0 | | 0 4 0 | |
| Fuel, oil and attendance | 1 0 0 | | 2 0 0 | | 4 0 0 | |
| Transport of green fibre to basins | 0 3 0 | | 0 3 0 | | 0 3 0 | |
| Soap ... ... | 0 13 4 | | 0 13 4 | | 0 13 4 | |
| Washing ... | 0 3 0 | | 0 3 0 | | 0 3 0 | |
| Drying ... ... | 0 8 0 | | 0 8 0 | | 0 8 0 | |
| Brushing ... | 0 8 0 | | 0 8 0 | | 0 8 0 | |
| Baling ... ... | 0 8 0 | | 0 8 0 | | 0 8 0 | |
| Transport to Port Louis | 0 7 0 | to 1 0 0 | 0 7 0 | to 1 0 0 | 0 7 0 | to 1 0 0 |
| Miscellaneous ... | 0 8 4 | | 0 8 4 | | 0 8 4 | |
| Total ... ... | 11 0 0 | to 12 8 0 | 12 0 0 | to 13 8 0 | 14 0 0 | to 15 8 0 |

Every effort is being made to reduce the cost of production. The fuel item is heavy where steam is employed, and this is being met by the installation of suction gas plants. Gratteurs are at times difficult to procure, and therefore a small automatic feeding machine is being constantly inquired for.

### *Exports.*

The exports of fibre from Mauritius show a slight upward tendency. The largest amount exported during the past fifteen years in any one year was 3,105·3 metric tons in 1900. The export last year (1913) amounted to 2,912·7 metric tons. The average yearly export for the five-year period 1899-1903 was 2,052·3 metric tons; for the period 1904-08, 2,113·1 metric tons; and for 1909-13, 2,238·1 metric tons. The exports during the past five years have been more regular than during former periods. There are reasons to suppose, however, that after the activity of 1913 (resulting in the export of nearly 700 tons above the average for the last five-year period), coupled with the fact that flowering took place very freely throughout the whole Colony after the somewhat extended dry period, August to December, 1913, there may be recorded in the exports for the next year or so a reduction of output.

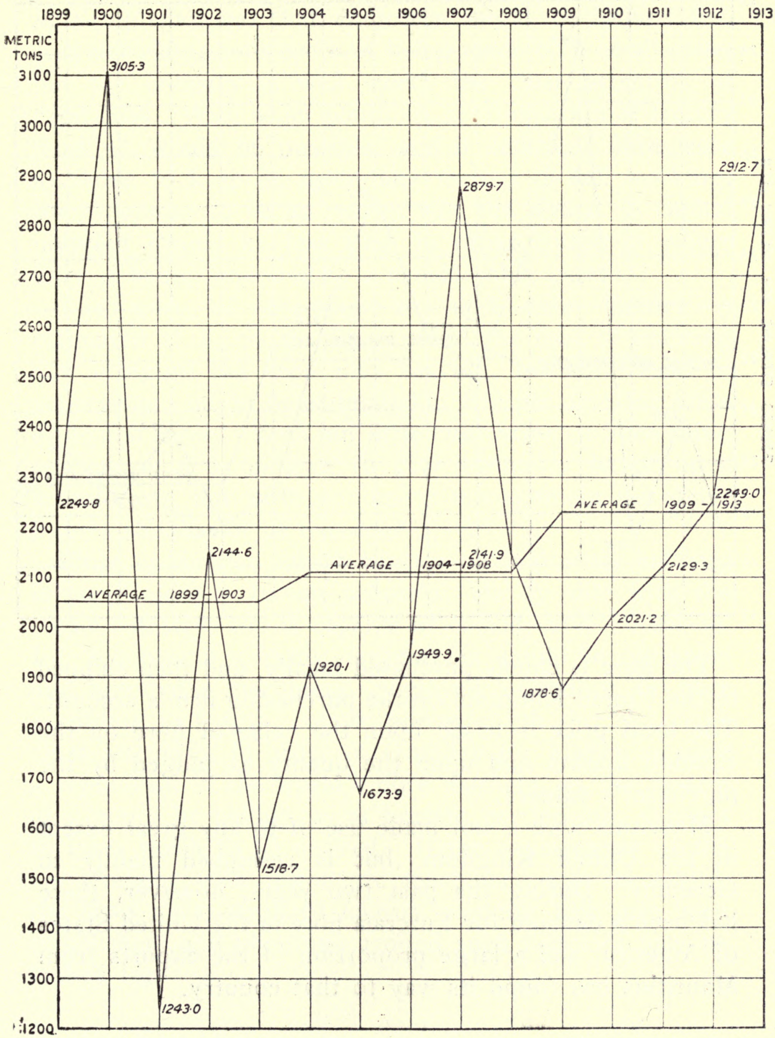
The value of the fibre crop in Mauritius averaged during the 1899-1903 period £44,884 yearly; during the 1904-08 period it was £47,192; and in 1909-13 the yearly average value was £43,843. The local price for fibre has ruled more steady during the past five years, but has been lower than the average price of the previous ten years; it has approximated to £20 per metric ton. The charges for freight, etc., to London may be estimated at £6 8s. per ton.

The quantity and value of the exports during the past fifteen years are shown in the following table:—

| Year | | Quantity. Metric tons | | | Value in Mauritius £ | |
|---|---|---|---|---|---|---|
| 1899 | ... | 2,249·8 | | ... | 39,245 | |
| 1900 | ... | 3,105·3 | | ... | 65,003 | |
| 1901 | ... | 1,243·0 | 2052·3 | ... | 22,896 | 44,844 |
| 1902 | ... | 2,144·6 | | ... | 60,525 | |
| 1903 | ... | 1,518·7 | | ... | 36,749 | |
| 1904 | ... | 1,920·1 | | ... | 41,835 | |
| 1905 | ... | 1,673·9 | | ... | 37,637 | |
| 1906 | ... | 1,949·9 | 2113·1 | ... | 49,173 | 47,192 |
| 1907 | ... | 2,879·7 | | ... | 65,760 | |
| 1908 | ... | 2,141·9 | | ... | 41,557 | |
| 1909 | ... | 1,878·6 | | ... | 35,380 | |
| 1910 | ... | 2,021·2 | | ... | 41,833 | |
| 1911 | ... | 2,129·3 | 2238·1 | ... | 40,033 | 43,843 |
| 1912 | ... | 2,249·0 | | ... | 45,465 | |
| 1913 | ... | 2,912·7 | | ... | 56,905 | |
| | Average | 2134·4 | | | £45,306 | |

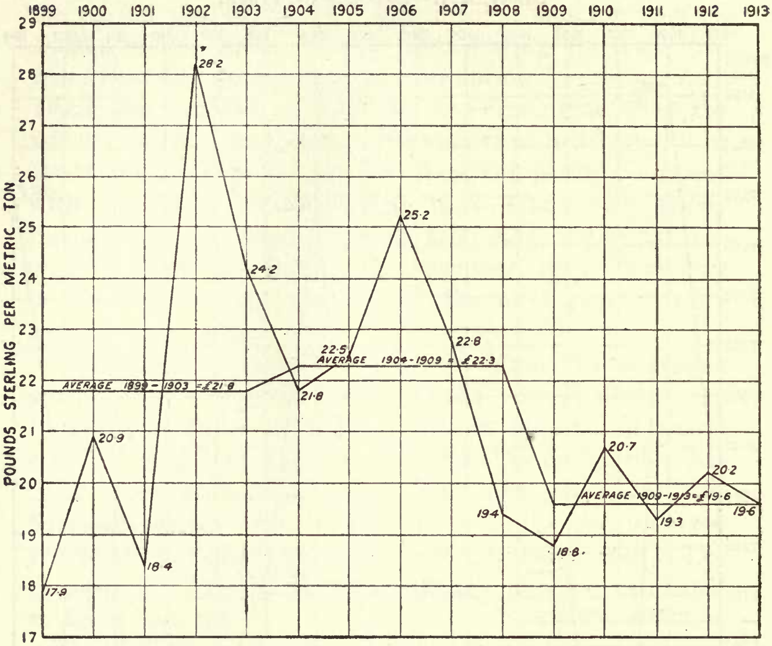
The fluctuations are more clearly shown in graph form, thus:—

Diagram I.—Exports of Fibre.



The fluctuations in the local value per metric ton of fibre are shown in the following diagram:—

DIAGRAM II.—LOCAL VALUE PER METRIC TON OF FIBRE.




The fibre is chiefly purchased locally, and then shipped to the United Kingdom on the purchasing firm's account. The local price is based upon the value of fibre on the London market and upon the quality as judged by the purchaser's valuers.

Mauritius fibre is not made use of to any great extent in the United Kingdom, but is reshipped mainly to Germany. During the past two years, however, there has been a demand for Furcræa fibre in the United States of America, and a large proportion of the exports from Mauritius has found its way to that country.

*Capital and Possibilities for Extension.*

The industry is worked on very little capital, and therefore it does not increase as fast as might be expected, considering the suitability of soil and climate. There are in the Colony large areas of land which are well suited for plantations of fibre. The greater portion of the Black River district might produce fibre without undue competition with sugar-cane, and it is in this district and in Pamplemousses that extension might be looked for. Regular plantations are now being made on a small scale, but the industry is well worth the close attention of capitalists. With wider plantings centralization of factory working would be possible, and if sufficient fibre were available to keep an up-to-date factory in full working, there appears to be no reason why the return on capital invested should be less than in other countries where fibre is being exploited to a considerable extent.

The cost of erecting an up-to-date factory is estimated at £3,000 to £3,500, and the cost of planting and bringing the crop into bearing, including cost of supervision, might be estimated at £10 per acre for areas up to 100 acres. With but little cultivation of fibre being carried on it is difficult to give estimates based upon actual costs, but with economical management the above figures should not be exceeded.

Fibre production might become an important industry in the Colony. It can progress side by side with the sugar industry, and is capable of considerable extension. For economical working, large areas should be cultivated and automatic machinery employed. Grading of fibre according to length, colour, and strength should receive close attention, in order to establish for Mauritius fibre a reputation in the world's fibre markets, as the system of grading by colour, as at present carried out, appears to leave much to be desired. If the experiments of the Government with automatic machinery are successful, the basis for centralized factory working will have been established, and plantings around such factories may be looked for.

## THE PRESENT POSITION AND PROSPECTS OF FIBRE CULTIVATION IN THE GERMAN COLONIES.

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The most important German Colony from the point of view of fibre cultivation is German East Africa, where cotton and sisal hemp are grown, and where formerly sansevieria fibre and Mauritius hemp were produced. The last-mentioned fibres, however, have practically ceased to be exported. In Togo cotton is of some importance; in addition, sisal has of late years been cultivated there, the amount produced being, however, only twenty tons.

Sisal is also grown in New Guinea. Isolated experiments with fibre plants have been begun in other Colonies, but they do not require mention in connection with the world's commerce. Mr. Schanz having undertaken to read the paper on cotton growing before this Congress, I may limit my remarks to fibre cultivation.

Germany is greatly interested in the cultivation of hemp-producing plants in her own Colonies. According to the official statistics for 1913, the German Empire imported from foreign countries fibre materials as follows:—

| | Quantity. Tons | Value. Million marks |
|---|---|---|
| Flax, raw and cleaned | 71,204·3 | 60·9 |
| Flax tow | 22,388·5 | 15·0 |
| Hemp | 45,698·1 | 35·2 |
| Hemp tow | 15,998·5 | 9·8 |
| Ramie and ramie waste | 2,396·4 | 2·3 |
| Jute and jute tow | 162,077·6 | 76·2 |
| Manila hemp tow | 3,993·1 | 2·1 |
| Sisal hemp | 3,609·3 | 1·9 |
| Kapok | 3,334·2 | 4·8 |
| Other fibres and waste | 22,448·9 | 9·8 |
| Totals | 353,148·9 | 218·0 |

Whilst the first four mentioned materials are mainly produced in Europe the others are all of tropical origin.

## Sisal Hemp.

The production of fibres in the German Colonies has been most successful in German East Africa, where *Agave sisalana*, Perrine, from whose long, succulent leaves (over 2 m. in length) sisal hemp is obtained, is the only fibre plant of commercial importance. The attempt to stimulate the culture of agavæ in German East Africa was begun in 1893, when, on the advice of Dr. Hindorf, seeding material from Florida was first secured for the Deutsch-Ostafrikanische Gesellschaft. The development of its production has been very rapid. In the last nine years the export of sisal hemp from German East Africa has been:—

| | Quantity. Tons | Value. Marks |
|---|---|---|
| 1905 | 1,397 | 1,071,296 |
| 1906 | 1,854 | 1,368,169 |
| 1907 | 2,830 | 2,161,685 |
| 1908 | 3,897 | 2,865,633 |
| 1909 | 5,284 | 2,333,025 |
| 1910 | 7,228 | 3,011,625 |
| 1911 | 11,213 | 4,532,249 |
| 1912 | 17,079 | 7,359,861 |
| 1913 | 20,835 | 10,711,591 |

In the beginning of the year 1908, 14,204 hectares were planted with agavæ, 4,376 of which were ready for harvest; in the beginning of the year 1913 the cultivated area had increased to 24,751 hectares, of which 14,359 hectares were paying.

The greater part of Germany's demand for sisal is already supplied by East Africa. Whilst formerly Yucatan sisal hemp almost alone was at the disposal of German industries, this fibre has now quite lost its field in Germany, whereas East African hemp is in increasing demand. According to the unanimous view of experts, the sisal hemp grown in German East Africa is so excellent as to surpass the sisal fibre of other countries. Indeed, the best quality of East African sisal is almost equal to the much more expensive Manila hemp in many respects, and in some points it is even better. This fact has been particularly established for binder twines. In addition, our Colonial hemp is also suitable for the manufacture of different kinds of ropes. The German Imperial Navy also employs a considerable amount of cordage made from this East African material. For this reason Germany is greatly interested in growing such fibre material for its own needs. The interest, however, does not go any further, since sisal is so small an article that if the production increases prices would rapidly fall. It is doubtful whether under such conditions it would pay to grow sisal.

*Distribution and Description of the Plant.*

The sisal grown in German East Africa (*Agave sisalana*, Perrine), sometimes called "green sisal," is identical with "Henequen verde" (Spanish name) and "Yaxci Maya" (Indian name), syn. *Agave rigida sisalana*. The plant is a native of Central America, and probably also of Yucatan. The fibre is used in small quantities by the natives of Central America, but does not enter into consideration for purposes of exportation. The plant has been introduced into Florida, where it has spread to some extent without being cultivated. As a trade article it is grown in the Bahamas, the Turks and Caicos Islands, in the Sandwich Islands, and here and there in British India and Indo-China. As regards its geographical occurrence, it is more widely distributed than any other fibre-producing agave.

The propagation of the sisal plant takes place either by means of suckers growing underground, or by so-called "bulbils," *i.e.*, adventitious shoots arising from the top of the flowering stem, where they develop into young plants. After having attained a size of 12 to 15 cm. the bulbils fall off, and may then be at once employed for seeding purposes in suitable beds.

On the whole, however, we nowadays prefer to employ the underground suckers for the purposes of propagation. After two or three years these suckers throw up young leaves, which obtain their nourishment partly from the mother plant, and partly through a separate system of roots which surround the plant in a radius not exceeding

1 metre. The daughter plant rarely develops a separate stem. The leaves are dark green or bluish-green, their length is about 1·75 m., their width near the central part 8 to 14 cm., and their thickness in the narrowest portion near the base of the leaf 2 to 4 cm. Marginal spikes are only found occasionally; when present, they are slightly bent and point downwards, their length being 25 to 28 mm. The flower-bearing stem attains a length of 4 to 8 m., and carries slender branches pointing upwards. The flowers are about 6 cm. long. Immediately beneath them arise the bulbils which have been mentioned previously. Nothing is so far known concerning the development of seeds.

*Cultivation.*

If it is intended to use bulbils for cultivation these are first reared in nurseries; if, on the other hand, suckers are to be employed, they are usually planted out in the field at once. Care should be taken to plant suckers of approximately the same size. It would be a mistake, *e.g.*, to plant a sucker whose main stem is 30 cm. long next to another one 50 cm. in length. Such differences in size render harvesting difficult; besides, the hemp obtained is irregular and the quality of the product suffers. Large suckers yield mature leaves earlier, thus reducing the time required for the harvest.

Before the beginning of cultivation the area is parcelled out, the shrubs are burned down, and the ground is carefully measured and marked out. The plants are then planted out, no further preparation or digging of special holes being required. Considerable differences may be observed with regard to the planting distances employed. Should inter-cultivation of other plants between the agavæ be intended—a point which will receive further consideration subsequently—the distance should, of course, be comparatively great, say, 2·5 by 2·5 m. Other distances employed are 2·5 by 1·25, 2·25 by 1·25, or 2 by 2 m. As the normal planting distance we may regard 2·5 by 1·25 m. It is inadvisable to make the intervals too short, *e.g.*, 2 by 1 m., or less. With sucker plantations it is usually difficult to avoid some degree of irregularity, and in this respect there is a distinct advantage in cultivating bulbils that have been reared in nurseries.

When cultivation is first started the plants are usually obtained from a considerable distance. The cost of carriage may in such cases be reduced by the use of bulbils, which are first placed in nurseries, and there develop into young plants. But when the cultivation has progressed so far as to have suckers available—usually in the course of the second year—the planter will, of course, use these for planting purposes after having previously sorted them according to their size, especially where a sufficient stock of light railway rails is available. At a later stage of cultivation, when both bulbils and suckers have developed, the question of transport alone will decide which material had best be used for growing, viz., suckers where there are enough rails, otherwise bulbils reared in nurseries.

During the first two years care must be taken to prevent grass from growing in the plantation, and particularly overgrowing the agavæ, otherwise in damp weather the plants will show signs of rot and become infected with fungi. Later, when the plants have grown so tall that there is no danger of their being overgrown by grasses, such scrupulous care to keep them free from weeds is unnecessary. During the dry season it is even advisable to leave the grass untouched because of the shade it affords.

A very important question is whether one should inter-cultivate other plants among the agavæ. During the last few years experience with regard to this question has been gained in German East Africa. At first cotton was used for this purpose, owing to the cotton prices and the state of the German cotton market at that time. On the whole, however, it should be noted that a good cotton soil and a good sisal soil are incompatible. Good results have, it is true, been *calculated* for cotton inter-cultivation in certain sisal plantations; but this was only possible because the cost of weeding was debited entirely or to a great part to the cultivation of the agavæ, inasmuch as weeding would have been required, even if no inter-cultivation had been practised. In countries where the rainy and the dry season cannot be accurately determined beforehand it is not expedient to inter-cultivate cotton. Where, however, the climate is suitable for cotton growing, as in the south of the Protectorate, the inter-cultivation of cotton will pay well in the earlier stages of agave growing, especially in newly started plantations. For, whilst the agavæ are developing, the produce of cotton culture will be sufficient to cover a considerable part of the expenses.

Various kinds of beans have also occasionally been used for inter-cultivation, but never to any extent. In some cases the result was not satisfactory, climbing beans, which twine around the young plants, proving especially injurious.

Great importance attaches to the methodical *renewal* of the plantation. The following calculation may serve as a typical instance:—

A stock of 1,000,000 plants requires a total area of 2,000 hectares[1] when worked in regular rotation, and if the planting distance be 2·5 by 1·25 m., *i.e.*, about 3,200 agavæ to the hectare. For every million plants it is necessary to plant out one-third, viz., 340,000 young plants, every year, this number representing a surface of 110 to 120 hectares. Thus, 1,000,000 agavæ requires 325 hectares of soil. The second million of agavæ, which must in time replace the first, requires a further area of 325 hectares, thus giving a total of 650 hectares. When the first lot of agavæ filling a space of about 110 hectares has run its course (*i.e.*, between the sixth and seventh years, when the flower-bearing stem develops), a fresh space of 110 hectares must be planted. In this way cultivation is worked in regular rotation over the whole area of 1,836 hectares. Thus, after the first lot has been harvested at the end of the seventh year, and the ground has subsequently lain fallow for a sufficient number of years (seven years under normal conditions, but this time varies according to special requirements), it again becomes ready for cultivation.

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[1] This figure allows for roads, factories, building extensions, etc.

If less efficient methods of cultivation are employed, *e.g.*, "wild cultivation," which will be described later on, replanting is carried out on totally different lines.

*Harvesting.*

As to the time of ripening of the leaves no definite statements can be made, since it depends upon various circumstances. Differences are seen between cultures derived from bulbils and those grown from suckers. Furthermore, the growth of the plants, and therefore the term of their harvest, is greatly influenced by the quality of the soil. In fact, it will be well to mention especially that the quality of the soil exerts a greater influence than climatic conditions. For example, one may note that after several months' drought the plants may do quite well and produce particularly firm leaves, an observation which recalls the intensive growth of our indigenous plants after their winter's rest.

The right time for cutting the leaves will be discussed subsequently. At present it will suffice to mention a sign of the ripeness of the leaves; in young leaves the tips are purplish-brown and glossy, but when the leaf matures it has a silver-grey hue.

In German East Africa cultivation is at present carried out chiefly in two ways. One is that of "methodical cultivation," already dealt with, the other is that of "wild cultivation." If the soil is not too rich and does not contain too much humus it is considered typically suitable for sisal culture in most tropical countries. Under such "normal" conditions the first leaves can usually be cut three years after planting. One may then continue harvesting the leaves for about five to seven years. In general, a sisal plant produces about 200 leaves suitable for fibre production during its entire lifetime. Normally, therefore, one whole period of sisal cultivation lasts for about ten years.

With regard to the influence of the soil on the ripening of the leaves one should distinguish (1) very rich virgin soils, (2) medium soils with a certain amount of nutritive material and humus, and (3) poor soil, *e.g.*, rocky or chalky soil near the sea coast. The medium soils we would regard as the most suitable, and it is for them that the figures stated previously for the time of harvest and period of life are normal. In richer soils the first harvesting of the leaves must be begun far earlier—this has proved to be particularly the case in the plantations of Usambara. In that district the suckers produce fully developed mature leaves as early as a year and a half after planting out. On such soils, however, the plant may have completed its term of existence within three years. On poor soils, on the other hand, the agavæ do not produce mature leaves until four or five years after having been transplanted as suckers; but there the lifetime of the plants is, as a rule, correspondingly longer. As regards the results of cultivation on these different kinds of soil, the medium and poor soils on the whole yield a better quality and a greater amount of fibre. But the first-mentioned soils contain so much nutritive material that at the end of the first period of cultivation a new period of plantation can begin immediately without any intermediate process of manuring being required. After the second term of planting this soil has become so exhausted as to approximate the medium soil which we consider as the best suitable.

The general rule for a methodically worked plantation must always be that each plant yields about 200 fibre-producing leaves, and that 3½ to 4 per cent. of the entire leaves consists of the fibre material. It is a matter of comparative indifference whether this result is attained sooner or later, according to the quality of the soil. In plantations which are worked in a really methodical manner, a far-sighted manager is always able to put a definite quantity of fibre on the market from any kind of soil.

In "rational cultivation" the root suckers, of which often a large number grow around each individual plant, are regularly removed, whilst in "wild culture" the suckers are allowed to develop freely. An advantage of the latter method of culture is that a sufficient amount of leaves is always available without the labour and expense required for fresh planting. In certain plantations of German East Africa this method of cultivation has occasionally proved fairly satisfactory, particularly in districts which have been worked inefficiently for many years previously. The old manager having been discharged, it becomes the chief aim of his successor to earn a dividend for the shareholders. As a rule he will not find sufficient mature leaves to feed the decorticating machines, and naturally it is his first object to obtain a sufficient amount of material rapidly—this end is attained with greater speed and certainty by "wild cultivation."

On the other hand, this method of cultivation has serious drawbacks. Such plantations are not easily kept free from weeds, and it is very difficult to gain access to them. The harvestable leaves are unequal, and so is the resulting fibre material. Besides, in such plantations the leaves are far more frequently infected with fungi and bacterial diseases than in well-kept plantations. The weeds often grow over 6 ft. high in such fields, affording cover to countless enemies of the plants. Thus we must bear in mind that in such cases dangerous antagonists of the agavæ may find their way into the plantation, and may spread epidemically under conditions favouring their development. A further menace to this method of plantation is that under wild cultivation the sisal plant more easily succumbs to the fate of almost all cultivated plants, viz., that it begins to degenerate. This has already occurred to some extent with the species grown in Java.

It should, therefore, be noted that by "rational cultivation"—*i.e.*, by taking proper regard of accurate planting distances and of regular weeding of the field—better results must be obtained in the long run than by the last described method of "wild cultivation." Above all, the quality produced will be more uniform.

According to the development of the leaves, the agavæ are usually allowed to grow for two and a half or, more commonly, three years, before the first cutting is begun. The first harvest of leaves as a rule produces a very irregular material, thus necessitating preliminary sorting of the leaves. From each plant one can obtain at the earliest term of harvest forty to forty-five leaves; at the proper term up to sixty leaves. In the following year, and as a rule also in the third year, the number of harvestable leaves may rise to seventy. Generally speaking, the number of leaves produced by a sisal plant during its whole lifetime is between 170 and 200 leaves. As soon as the flower-bearing stem becomes visible it should at once be cut down, unless bulbils are desired, since otherwise the leaves surrounding the stem will not yield proper fibre. The old rule was only to cut those leaves which formed an angle of 45° with the ground. This has proved a mistake, especially in the richer class of soils. In such cases, if the leaves forming an angle of more than 45° with the horizontal are not cut, the result would be that the flower-bearing stem would shoot up too soon, and thus the life of the plant would be shortened.

After the whole sisal culture has been completely harvested it is advisable to let the ground lie fallow for several years. Exhaustion of the soil can also be avoided by cultivating leguminous plants which enrich the nitrate content of the soil.

### *The Extraction of Fibre from the Leaves.*

Fibre extracting is performed by various machines, which are worked either by hand or mechanically. The method by which the flesh is removed from the leaves in such machines is that a rotary drum set with beater ledges presses the leaf against a hard edge, thus beating out the flesh whilst the fibres are gripped above. The leaves are inserted by hand in the so-called "raspadores," and automatically in the larger machines, *e.g.*, the "New Corona." In the raspadores each leaf is inserted separately into the machine with its tip foremost, half of the leaf being thus freed from flesh; it is then removed and its other end inserted into the machine. In the "New Corona" one side of the leaf is gripped by the machine and carried sideways towards a drum, which removes the flesh from the other side; then the part freed from flesh is gripped and carried towards a second drum, which removes the flesh from the remainder. The general principle is the same in all the different systems of extracting machines; the difference being that in some the leaves are transported by chains consisting of links of bronze (Finigan machine), or by spiked wheels of bronze (Mola machine), in others by hempen ropes (New Corona machine). With the large machines, the work performed is, of course, far greater than with the raspadores or "double raspadores," which derive their name from the fact of two raspadores being fixed on one driving shaft. The raspadore principle has the drawback that some of the flesh remains in the central part of the leaf, and this must afterwards be removed. On the other hand, the raspadore apparatus is far cheaper, and would appear to yield a better quality of hemp and less waste; it is also, of course, much simpler to work. Besides, it will always be possible to set up more than one of these cheap machines, and there is thus no danger that in case of a breakdown or other accident the whole factory and work of harvesting would come to a standstill; whereas this possibility must not be lost sight of with the larger machines, of which only the greatest plantations can afford more than one.

It can be stated as a general rule that the amount produced by a double raspadore is almost half a ton daily, for which 5 to 7 h.p. are required. The large machine most commonly used in the Colony is the "New Corona," constructed by the Krupp-Gruson Works of Magdeburg. It is built in two types, which are stated by the makers to require 40 and 30 h.p., and to yield 2 and 1½ tons of fibre daily respectively.

It is hardly advisable to give any detailed figures as to the capacity and working expenses of the various systems of machines. The several factories at present in existence show so many differences that it is hardly possible to make any general statement as to the cost of construction and working of sisal plantations. Further information will be found in a paper by Hupfeld in the *Tropenflanzer* (1910, pp. 532-539) and in the annual statements of the larger sisal plantation companies of the Colony, whilst a detailed account of the cultivation and its commercial aspects is given in a paper published by myself[2] last year.

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[2] Bruck, W. F.—"Die Sisalkultur in Deutschostafrika," *Arbeiten der Deutschen Landwirtschafts-Gesellschaft,* 1913, Heft 244.

The results of sisal cultivation in other German Colonies have not been particularly important as yet. In Togo sisal hemp is produced by the Kpeme plantation, where, in 1913, 263 hectares were cultivated, of which 68 hectares were producing. This plantation exported 10,492 kilograms of fibre in 1911 and 17,571 kilograms in 1912.

In New Guinea, experiments carried out with sisal hemp have given the following results, as shown by the export figures:—

| | Quantity. Kilograms | Value. Marks |
|---|---|---|
| 1909 ... ... ... | 3,242 ... | 1,945 |
| 1910 ... ... ... | 13,782 ... | 8,269 |
| 1911 ... ... ... | 7,686 ... | 3,843 |
| 1912 ... ... ... | 21,342 ... | 10,540 |

In 1913 the surface cultivated was 78 hectares containing over a quarter of a million plants.

In comparison with the export of German East Africa, the quantities exported by Togo and New Guinea are not particularly important as yet. But it should be considered that in these Colonies cultivation is only just beginning.

On the whole, we may say that we have been fortunate with this branch of cultivation in our Colony of German East Africa. But nothing definite can as yet be stated with regard to the future of sisal. During the last few years there has been a great demand for fibre material owing to the enormous grain harvests in North America, which required large quantities of binder twine; thus prices were influenced favourably. But it is by no means certain that such fortunate circumstances will recur in the future. If fibre cultivation should increase in other Colonies overproduction might easily occur, and prices would then rapidly fall. Under such conditions it is doubtful whether sisal cultivation would continue to pay.

Wherever new plantations are started they must always be begun as experiments, for one can never tell beforehand whether the conditions of soil and climate will prove suitable for cultivation. In addition, it is necessary to have an adequate supply of workers. A further factor requiring to be considered in all calculations is that the plantation must first pass through a period of preparation lasting at least five years. If expensive large machinery is to be laid down profitably, a large area is required for planting sisal. The cost of such plantations is therefore a very heavy item.

## KAPOK.

Some years ago the cultivation of kapok trees (*Ceiba pentandra*, syn. *Eriodendron anfractuosum*) was also begun in the German Colonies. The silky hairs of the internal membrane of the capsules have the advantage of being very light and buoyant. In this respect kapok surpasses both pith and cork. Extensive use has therefore been made of kapok within recent years in the manufacture of swimming- and life-belts. The chief importance of kapok attaches, however, to its being an excellent substitute for the animal materials hitherto employed for stuffing cushions, mattresses, and other articles of upholstery.

The first lot of kapok was exported from East Africa in 1909, its amount being 18,137 kilograms. The consideration which has been accorded to kapok of late years has led to a further extension of its cultivation, which is at present increasing rapidly. The exports were as follows:—

| | Quantity. Kilograms | Value. Marks |
|---|---|---|
| 1909 | 18,137 | 9,080 |
| 1910 | 12,205 | 13,043 |
| 1911 | 28,637 | 23,014 |
| 1912 | 53,072 | 62,601 |

The area cultivated has increased from 694 hectares in the beginning of 1911 to 2,632 hectares in the beginning of 1913; of this surface, 641 hectares were ready to yield a harvest.

In Togo the cultivation of kapok has also been begun recently. A comparatively small quantity was first exported in 1911, the figures being:—

| | Quantity. Kilograms | Value. Marks |
|---|---|---|
| 1911 | 5,060 | 6,271 |
| 1912 | 7,062 | 7,142 |

Lately Cameroon has also exported a small quantity of vegetable fibre material, the exact nature of which is not, however, published in the official commercial statistics, viz.:—

| | Quantity. Kilograms | Value. Marks |
|---|---|---|
| 1911 ... ... ... | 156 ... | 85 |
| 1912 ... ... ... | 798 ... | 316 |

Perhaps it will prove possible to grow kapok there also, more especially since the decrease in rubber production affords sufficient opportunity for the beginning of other branches of cultivation.

## FIBRES OF THE NETHERLAND EAST INDIES.

By The Department of Agriculture, Industry and Commerce, Buitenzorg, Java.

*Introduction.*

The Netherland East Indies, like all other tropical countries, are rich in fibres of different sorts and qualities. The greater part of these fibres are of only local importance, and the only kinds which are adapted to export are kapok, rattan, agave, Manila hemp, and cotton; the fibre of the coconut palm, that of the arenga palm (*gemoetoe*), and the *widoeri* (a vegetable silk obtained from wild plants of *Calotropis gigantea*) are of little importance as articles of export.

Of the fibres exported, kapok, Manila hemp, and cotton are obtained from plantations. The fibres of the agave are obtained from plants growing wild and also from plantations, while the rattan is a product only collected from the forests.

The cultivation of fibre plants in the Netherland East Indies, except that of cotton, which has been exported to Europe since the beginning of the nineteenth century, is comparatively of recent date.

Kapok was exported for the first time in 1860, while the cultivation of agave fibre and that of Manila hemp dates from the beginning of this century.

The cultivation of cotton, which is carried on only by the natives, is gradually increasing, especially in the islands beyond Java and Madura.

The importance of the fibre trade of the Netherland East Indies is shown by the following figures of exports (in tons) in recent years:—

Rattan.

| | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|
| From Java and Madura ... ... | 515 | 422 | 774 | 441 |
| From the other islands of the Archipelago | 32,296 | 43,768 | 54,717 | 44,041 |
| Total ... ... | 32,811 | 44,190 | 55,491 | 44,482 |

KAPOK.

| | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|
| From Java and Madura ... ... | 7,965 | 8,377 | 9,906 | 10,295 |
| From the other islands of the Archipelago | 586 | 809 | 569 | 1,160 |
| Total ... ... | 8,551 | 9,186 | 10,475 | 11,455 |

COTTON (UNCLEANED).

| | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|
| From Java and Madura ... ... | 698 | 969 | 1,072 | 3,686 |
| From the other islands of the Archipelago | 6,682 | 7,041 | 5,374 | 6,318 |
| Total ... ... | 7,380 | 8,010 | 6,446 | 10,004 |

COTTON (GINNED).

| | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|
| From Java and Madura ... ... | 345 | 56 | 201 | 609 |
| From the other islands of the Archipelago | 65 | 118 | 231 | 523 |
| Total ... ... | 410 | 174 | 432 | 1,132 |

OTHER FIBRES (EXCEPT RATTAN CANES).

| | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|
| From Java and Madura ... ... | 835 | 1,817 | 3,784 | 7,335 |
| From the other islands of the Archipelago | 8 | 54 | 149 | 64 |
| Total ... ... | 843 | 1,871 | 3,933 | 7,399 |

The export of rattan canes, which come entirely from the islands of the Archipelago adjacent to Java and Madura, during the same period showed a value of (in dollars):—

| 1909 | | 1910 | | 1911 | | 1912 |
|---|---|---|---|---|---|---|
| 71,247 | ... | 50,032 | ... | 56,826 | ... | 60,582 |

## KAPOK.

*Distribution and Cultivation in the Netherland East Indies.*—The kapok tree, belonging to the family of the Bombacaceæ, is to be found throughout the Netherland East Indies, but principally in Java, which is responsible for about seven-eighths of the total export of kapok from the whole Archipelago.

Java kapok, which is superior to the product from elsewhere, is obtained from the fruits of *Ceiba pentandra*, L. (*Eriodendron anfractuosum*, DC.). Kapok of inferior quality from British India, Cochin-China, and Ceylon, is obtained from the fruits of *Bombax malabaricum* and other species of *Bombax*. In recent years the Government of German East Africa has spared no trouble to encourage the cultivation of kapok in that Colony in order that a product may be obtained, both as regards quantity and quality, to compete with the Java product in the world's market.

The kapok tree requires very little care, and thrives well when planted in any soil; climate also does not affect it to any large extent. For increasing or renewing the cultivation of kapok, the common method of propagating is by setting out cuttings from the older trees.

With its straight trunk and a few long horizontal branches almost devoid of sprigs, and its scanty foliage, the kapok tree has a peculiar and impressive appearance.

The kapok tree is to be found in Java, not only on lands belonging to the natives, but everywhere along fields and roads, while some estates under European management are interested in its cultivation. The area planted with kapok trees on January 1, 1911, amounted to:—

| | |
|---|---|
| In Java and Madura ... ... ... | 68,129 acres |
| In the other islands of the Archipelago ... | 4,419 ,, |
| Total ... ... ... ... | 72,548 acres |

Of this total, an area of 52,661 acres in Java and Madura is under cultivation carried on by the natives, and in the other islands of the Archipelago an area of 4,293 acres.

*Preparation.*—The principal work of the kapok preparation is the removing of the seeds, which is done either by hand or mechanically by beating the kapok so that the seeds are freed and can be removed.

These seeds form a by-product, and are used by oil manufacturers in Europe.

The kapok, after being separated from the seed, is pressed.

On the plantations under European supervision much attention is paid to the pressing, but in the establishments managed by Chinese the pressing is often very carelessly done.

The kapok is packed in gunny bags or matting, after which the bales intended for shipment to Australia—which are of a net weight of 72 to 80 lb. and measure 16 cubic ft.—and the bales for shipment to Europe and America—which are of a weight of 90 lb. and measure 12 cubic ft.—are bound by iron bands or sometimes by rattan. Bales which are not properly pressed are often tied two together, in order to reduce the quantity of kapok protruding at the sides and ends of the bales.

*Trade.*—It is only during the last fifteen years that the kapok trade of the Netherland East Indies has become of such great importance, although, as mentioned above, kapok was first exported to the Amsterdam market in 1860.

The kapok trade in Java is mainly in the hands of European exporters in the principal ports. Kapok is also sold and shipped directly to foreign purchasers by the European planters, but this represents a very small percentage of the total exports, and is not more than 20 per cent. of the total output.

The chief markets for Java kapok are the Netherlands and Australia, although direct shipments are now made to America, France, Germany, Italy, and Spain, and have increased considerably during the last few years, while formerly these countries were supplied by the Amsterdam market. The consumption of kapok in England, Russia, Sweden, and Norway is still comparatively small, but is regularly increasing. The principal countries to which kapok from the Netherland East Indies has been exported for the past three years were (in tons of 1,000 kilograms):—

FROM JAVA AND MADURA.

| Countries of destination | 1910 | 1911 | 1912 |
|---|---|---|---|
| Netherlands ... ... | 2,848 | ... 2,282 | ... 3,136 |
| Netherlands f/t ... | 515 | ... 1,103 | ... 1,090 |
| France ... ... | 227 | ... 209 | ... 216 |
| United States of America | 1,798 | ... 2,050 | ... 2,044 |
| Singapore ... ... | 346 | ... 457 | ... 386 |
| Australia ... ... | 2,006 | ... 2,480 | ... 1,605 |
| Australia f/t ... ... | — | ... 333 | ... 81 |
| New Zealand ... ... | 321 | ... 472 | ... 536 |
| Other countries ... | 316 | ... 520 | ... 1,201 |
| Total ... | 8,377 | 9,906 | 10,295 |

During 1913 a total quantity of 9,019 tons was exported from Java and Madura.

FROM THE OTHER ISLANDS OF THE ARCHIPELAGO.

| Countries of destination | 1910 | 1911 | 1912 |
|---|---|---|---|
| Netherlands ... ... | 360 | 377 | 822 |
| Netherlands f/t ... | 84 | 8 | 43 |
| Penang ... ... | 64 | 55 | 90 |
| Singapore ... ... | 292 | 128 | 174 |
| Other countries ... | 9 | 1 | 31 |
| Total ... | 809 | 569 | 1,160 |

*Uses.*—Kapok can be used for many purposes, and, when more generally known, it no doubt will have a good future.

As a stuffing material for cushions, mattresses, etc., kapok seems to be gradually taking the place of the more expensive horsehair. It is specially valuable for such purposes, as it does not absorb dampness quickly, but remains fresh, and does not form a compact substance which causes discomfort in use. It is very elastic, and maintains its elasticity for a long time, owing to which comparatively small quantities are found sufficient for stuffing cushions, mattresses, etc.

Compared with quantities of other materials required for stuffing mattresses, the following figures speak for themselves.

A single mattress of 3 by 6½ ft. requires:—

| | |
|---|---|
| Java kapok ... ... ... ... | 17·6 to 19·8 lb. |
| Horsehair ... ... ... ... | 26·4 ,, 28·6 ,, |
| Seaweed ... ... ... ... | 33·0 ,, 35·2 ,, |
| Crin végétal ... ... ... ... | 26·4 ,, 28·6 ,, |
| Wood shavings ... ... ... ... | 33·0 ,, 38·0 ,, |
| Alpine grass ... ... ... ... | 25·4 ,, 28·6 ,, |
| Straw ... ... ... ... | 28·6 ,, 82·0 ,, |

It might be mentioned that when horsehair, crin végétal, etc., is used, the stuffing is frequently enclosed in a thin layer of kapok or wadding to give the mattress the necessary softness.

*Properties.*—Kapok absorbs very little moisture, owing to which fact a mattress stuffed with this material, when it once becomes damp, is soon dried, while the covering stands less chance of rotting away. Moreover, dry sterilization of kapok is possible without the product losing any of its properties.

It is not surprising, therefore, that the use of kapok as a stuffing material for Army mattresses is rapidly increasing. Trials, conducted by the German military officials, resulted in a decision that henceforth no other material but kapok should be used for this purpose.

Kapok has also been found a very useful and important article for stuffing lifebelts and other appliances designed to support heavy weights in water. Java kapok, having great buoyancy, can carry twenty to thirty times its own weight in water, while British India kapok can carry ten to fifteen times its own weight, and cork only six times its own weight. Java kapok does not lose its buoyancy even after having been submerged for some days and then dried. After thirty days' submersion kapok loses only 10 per cent. of this property. A lifebelt filled with 2 lb. of kapok can carry a weight of 50 lb. in water.

The above-mentioned properties are found in much higher degree in Java kapok than in products of other growth.

Kapok is at present also used for spinning purposes. Some years ago a German concern decided to spin this fibre into yarns of various thicknesses. These yarns are used for carpets, clothes, etc. Kapok is also used in the manufacture of felt hats and in gun-cotton factories.

## Rattan.

*Distribution in the Netherland East Indies.*—Rattan is a more or less slender stem of various species of palms belonging to different genera, of which the principal is *Calamus*, sometimes subdivided into *Calamus* and *Dæmonorops*.

Rattan is to be found throughout tropical and subtropical Asia, mostly in the islands of the East Indian Archipelago, viz., Celebes, Borneo and Sumatra, and, in much smaller quantities, in Java.

Rattan in its natural state grows against trees, and is gathered by the natives from the forests. There is no proper cultivation of rattan in the Netherland East Indies, it being a product of the forests and growing wild.

*Preparation.*—The rattan is gathered by cutting the stem about 1 metre from the ground, the remaining part of the plant throwing out new shoots.

After cutting, the rattan is bleached for some days (at the most for three days), and is then washed and dried. Good specimens are dried in the sun, and inferior qualities over fire, which, however, very often causes a brown colour. After the drying the gravel on the rattan is removed by sharp pieces of wood, knives, pieces of glass, sand, or a piece of metallic netting.

*Trade.*—Rattan is an export article of great importance for the Netherland East Indies. The trade in this product with foreign countries is entirely in the hands of Europeans and Chinese.

A cheaper quality of rattan is sent to Java by the Arabs and natives.

The rattan suitable for binding and for basket work, and the better qualities of other kinds, which are thicker, as well as rattan canes, are exported entirely to Europe and America, where the demand depends on the ultimate destination.

Inferior kinds of rattan from East Borneo are exported in rather large quantities to Hong Kong. At the Singapore market, where large quantities of rattan from the Netherland East Indies are sold, the demand for the Borneo product is not so great. The exports of rattan from the Netherland East Indies for the years 1910, 1911, and 1912 (in tons) are shown in the following table:—

| Countries of destination | 1910 | 1911 | 1912 |
|---|---|---|---|
| Netherlands ... | 2,180 | 3,373 | 3,696 |
| United Kingdom | 2,373 | 3,014 | 2,827 |
| Germany ... | 6,764 | 9,101 | 7,279 |
| Hamburg f/t ... | 3,727 | 4,988 | 4,907 |
| United States of America | 381 | 428 | 69 |
| Penang ... | 1,098 | 1,499 | 1,396 |
| Singapore ... | 22,572 | 27,431 | 21,727 |
| Other countries | 5,095 | 5,657 | 2,581 |
| Total | 44,190 | 55,491 | 44,482 |

The following table shows the value in dollars of the shipments of rattan canes to the various countries of destination:—

| Countries of destination | 1910 | 1911 | 1912 |
|---|---|---|---|
| Netherlands ... | 7,683 | 6,351 | 6,422 |
| Netherlands f/t | 1,013 | 5,432 | 3,550 |
| United Kingdom | 978 | 2,018 | 2,884 |
| France | 3,069 | 57 | 889 |
| Germany | 1,544 | 3,646 | 2,774 |
| Singapore | 35,723 | 39,310 | 43,888 |
| Other countries | 22 | 12 | 165 |
| Total | 50,032 | 56,826 | 60,582 |

*Uses.*—Rattan of inferior quality is often used in Java as a material for binding purposes and basket work. The natives of the Netherland East Indies twist the rattan into different articles for daily use, especially furniture. The Netherland East Indies is an important consumer of its own product. In sugar mills and in other branches of industry, where strong material for binding is required, great quantities of rattan are used, which are specially imported to Java from Borneo. The dark-coloured kind of rattan is used by the natives for the manufacture of rigging, and in coal-mines and fisheries as basket material. In Europe and America also the rattan is much in demand, where it is used in the furniture industry and for the manufacture of trunks and basket work.

## Agave Fibres.

*Distribution in the Netherland East Indies.*—A great many different species of agave and fibre-producing plants of the same order are found in the Netherland East Indies growing wild, and the natives have for many years known the valuable properties of the fibres of the leaves of these plants, which are prepared by them in the most primitive way.

*Cultivation by Europeans.*—The fibre obtained by the natives is mostly short, insufficiently cleaned, and coloured. Owing to these circumstances this product would never have become an export article of much importance had not the European planters in the Netherland East Indies taken an interest in its cultivation. This took place at the beginning of this century, and the number of agave plantations rapidly increased when in the years 1903 to 1905 the prices were extraordinarily high. But after the last-mentioned year the price declined and remained unchanged, and for that reason the planters did not make the anticipated profits, and the cultivation progressed only slowly.

At the beginning of 1911 there were in Java some thirty-seven European plantations with 15,309 acres under agave cultivation, and some 681 acres of this plant cultivated by the natives in the Netherland East Indies.

*Agave Cantala and Agave rigida* var. *sisalana*.—Two species of agave are principally planted, between which there is a rather great difference, namely, *Agave Cantala* and *Agave rigida* var. *sisalana*.

*Agave Cantala*, which seems to be a native of Java, and which grows luxuriantly, yields a fibre showing very important differences compared with those of the true sisal hemp, the fibre of *Agave rigida* var. *sisalana*. The Cantala fibre is much thinner, more brilliant white, and more flexible than the sisal fibre, and owing to these properties it is suitable for spinning purposes for which the coarser sisal hemp is less suitable. Owing to this the foreign markets pay more for the carefully prepared Java Cantala fibre than for the sisal fibre.

*Cultivation and Preparation*.—Of the cultivation of these agaves only very little can be said as they require little care, and grow well on soils less suitable for other cultivated plants. The yield of leaves and the percentage of fibre are in this country almost equal to that of other countries, such as Yucatan and German East Africa, while in Java diseases and pests up to the present have only appeared sporadically, and are only very exceptionally observed in the plantations.

The preparation of the fibre by the natives is done, as already mentioned, in a very primitive way, namely, by drawing the agave leaves, which usually are beaten soft with a stone or a piece of wood, through a simple scraping apparatus. However, the fibre obtained in this way is usually short, and the colour as well as the cleaning often leaves much to be desired.

The fibre prepared by the natives is principally used locally, only small quantities being exported. On the plantations under European supervision, which are principally situated in Central Java and Kediri, the preparation of the fibre is done in a less primitive way, and fibre-extracting machines are in general use.

The fibre obtained by using these machines is sometimes brushed after having been dried, and is then sorted according to colour, depending on the requirements of the various markets.

On some plantations where, during certain periods of the year, the drying in the air proceeds too slowly, the fibre as soon as it leaves the machine is submerged in tanks filled with water. In these tanks the fibre is subjected to a kind of retting process, by which the substances which cause discoloration during slowly drying are rendered harmless.

*Packing.*—The Java fibre is packed in bales of 50 to 100 kilograms, which are bound by iron hoops. The iron hoops are very often substituted by bamboo, as the iron is apt to corrode and the quality of the fibre consequently suffer.

*Waste.*—The waste from the preparation, consisting of broken fibres, etc., is a material suitable for stuffing cushions of carriages and a valuable material for the manufacture of stronger kinds of paper. It is partly sold locally and partly exported to Europe.

*Uses.*—As is generally known sisal hemp is of much importance as a material for rope manufacture, and in this respect a competititor of the other kinds of rope fibres, such as Manila hemp, New Zealand flax, Mauritius hemp, etc.

The finer kinds of agave fibres are suitable for the manufacture of fabrics which have to answer high requirements of strength, and the Java Cantala has, on account of its cleanness, whiteness, high brilliancy, fineness, and flexibility, a brilliant future as a raw material for the weaving industry.

The real sisal hemp is not sufficiently useful for spinning and the subsequent manufacture of fabrics.

*Exports.*—The export of agave fibres from the Netherland East Indies has only during recent years grown in importance, as the result of the fact that the larger estates which were laid out since 1904 gradually reached the producing stage.

The export of this article during 1913 amounted to more than 8,700 tons, against about 6,000 tons in 1912, and about 2,000 tons in 1911. The following table shows the various countries of destination in 1912 and 1913:—

| | 1912. Tons | 1913. Tons |
|---|---|---|
| Netherlands and Netherlands f/t | 1,086 | 1,249 |
| Germany | 98 | 262 |
| United Kingdom | 188 | |
| France | 275 | 484 |
| Other European countries | 13 | |
| United States of America | 4,375 | 6,557 |
| Other countries | 96 | 196 |
| Total | 6,131 | 8,748 |

The principal ports of export are Sourabaya and Samarang, from which the export amounted to:—

| | 1912. Tons | 1913. Tons |
|---|---|---|
| Sourabaya | 5,882 | 8,188 |
| Samarang | 249 | 253 |

## Manila Hemp.

*Introduction.*—Manila hemp is obtained from the leaf-sheaths of the king of banana plants, *Musa textilis*, Nees, which seems to be a native of the Philippines and the Sangir Islands of the Netherland East Indian Archipelago. This species is being gradually planted in other parts of the Netherland East Indies, especially in Java, with a view to the preparation of the fibre.

*Cultivation.*—On high elevations the plants take longer to reach maturity or development, but the fibre obtained from such plants is stronger than from plants grown at lower elevations. This is evidently on account of the slower development of the plant.

To thrive well Manila hemp requires the rainfall to be equally distributed throughout the year. A long period of drought as well as a low temperature will stunt the plant.

Manila hemp is sometimes grown as a catch-crop on rubber estates.

Estates cultivating this fibre plant entirely showed an area of 957 acres at the beginning of the year 1911, of which 669 acres were in Java and Madura, and 288 acres in the other islands of the Archipelago.

*Preparation.*—The fibre is obtained from the leaf-sheaths of which the trunk is composed. The trunk is first cut down, and then the sheaths are one after the other peeled and the fibre is extracted by hand, or, on larger plantations, by machinery.

The fibre which is prepared by hand is, however, in every respect superior to that which is obtained mechanically, although the yield by the former method is smaller.

As the existing mechanical preparation requires rather much manual labour, the Manila hemp planters in Java are eagerly looking out for a better constructed machine, but up to the present their efforts have not met with success. During recent years trials have been made with a new so-called automatic fibre-extracting machine, which seems very promising, but it still remains to be seen whether it will turn out satisfactory in the end.

The sooner the drying process ends the smaller becomes the ever threatening danger of discoloration of the fibre, owing to which the value of the product can decrease considerably. The drying is done by hanging the fibre in the sun on a bamboo and turning it from time to time. Sometimes the fibre before being dried is washed once more. The dried fibre is often brushed—a method which causes considerable waste, and therefore it is not often done—and then it is sorted according to length and colour.

*Packing.*—The fibres are pressed and packed in bales of about 100 kilograms. During the packing, folding and twisting of the fibre must be avoided as much as possible. For the packing, matting or gunny bags are used. The bales are bound by hoops and are then ready for shipment.

*Exports.*—The export of Manila hemp from Java is still small, owing to the comparatively low prices which were realized during the years 1907 to 1912, and the planters, therefore, have not seen any inducement to extend their cultivation.

The export from Java and Madura to the undermentioned countries in 1912 and 1913 amounted to (in tons of 1,000 kilograms):—

| | 1912 | 1913 |
|---|---|---|
| Netherlands ... ... ... | 143 ... | 209 |
| United Kingdom ... ... ... | 10 ... | — |
| Germany ... ... ... ... | 13 ... | — |
| Total ... ... ... | 166 | 209 |

The export from the islands of the Archipelago adjacent to Java and Madura in 1912 and 1913 amounted to the following quantities which were shipped to the undermentioned countries:—

| | 1912. Tons | 1913. Tons |
|---|---|---|
| Netherlands ... ... ... | 62 | 51 (Netherlands and Japan) |
| Japan ... ... ... ... | 1 | |
| Total ... ... ... | 63 | 51 |

## Cotton.

*Distribution in the Netherland East Indies.*—The cotton plant grows best in the regions between 36° North and 36° South Latitude. Some varieties are also indigenous to the Netherland East Indies, especially those in Palembang, in Sumatra, and in Demak and Kediri, in Java.

*Cultivation.*—The cultivation of cotton in the Netherland East Indies is up to the present carried on entirely by the natives as a catch-crop. At first the product was only used for making clothes, which domestic industry, however, suffered very much from the import of woven goods of cheap manufacture, although to a certain extent it is still in existence.

The cotton cultivation carried on by European planters has, up to the present, not proved profitable, and European capital is concerned almost entirely with the purchasing of the raw product and the trade in it, and in some cases the supplying of seed and the cleaning of the product.

As an additional cultivation cotton has shown a certain vitality, which justifies the best hopes for the future, since the Government of the Netherland East Indies has given undeniable proofs that it is willing to look well after the interests of the cotton planters and to promote this cultivation.

Although the quantity of cotton which is yearly exported is not small, the indigenous varieties have but little importance for the spinning industry. The fineness leaves much to be desired and the staple is not long enough. As a consequence, when the Government of the Netherland East Indies resolved about the middle of the last century to support and to encourage cotton cultivation, in the first place in Palembang, this assistance was limited to the supplying of seeds of superior qualities imported from elsewhere. The indigenous varieties were considered to be so inferior that even the possibility of improving them by selection, so that the product should become of more importance to the world's trade, was considered non-existent.

The attempts of the Government to import exotic varieties of cotton which are considered to be superior were supported financially by some private companies, one of which was the Netherlands Trading Society. These attempts, however, had not the desired success, and, although the Government had no reason to abandon them, it rather preferred to pay more attention than hitherto to an improved quality by means of selection, and there is no doubt that lately this has proved to be the better course.

The attempts to import superior exotic cotton varieties by means of seeds from elsewhere, such as Sea Island and Upland cotton, were in the meanwhile continued in the eastern part of the Archipelago (in the island of Lombok), and up to the present have been successful, a favourable expert opinion having been expressed in Europe on the cotton grown in the said district.

*Cultivation and Crop.*—The principal cotton-producing region in the Netherland East Indies is Palembang, in Sumatra. As soon as the rice crop is over the natives sow cotton in the fields. The sowing is done by means of a peculiarly shaped stick, by which holes of about 2 cm. depth are made. In each of these holes three to five seeds are laid.

Much care is paid to the plantation for some weeks after the sowing, and the soil is kept well weeded until the plants are flowering and thriving well and until they are strong enough to withstand the weeds.

The picking is done either by removing the raw cotton from the pod after it has broken open—holding the boll with the left hand and then exercising a strong pull—or by picking all the pods and removing the husks. The first-mentioned method is preferable.

At the beginning of 1911 the area under cotton cultivation was as follows:—

| | Acres |
|---|---|
| In Java and Madura ... ... ... ... | 3,702 |
| In the islands of the Archipelago adjacent to Java and Madura ... ... ... ... ... | 18,222 |
| Total ... ... ... | 21,924 |

*Trade.*—A very small part of this product is cleaned by the natives in order to obtain seeds for planting purposes. The raw uncleaned product is bought by travelling Chinese and Arabs, and forwarded to the ports of shipment. These petty buyers sell the cotton to merchants in the ports of shipment, among whom there are some export firms. These firms have machines for removing the seeds before shipping the cotton.

The cleaned cotton is exported principally to Europe, where the labour expenses are too high to make the ginning of the raw product profitable; and, moreover, the cost of transportation of raw cotton would be prohibitive.

The export of ginned cotton from Palembang during 1905 and during the years 1909-1912 amounted (in tons) to:—

| Countries of destination | 1905 | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|---|
| Netherlands ... ... | — | — | 1 | — | 8 |
| Germany ... ... | — | 54 | 99 | 207 | 482 |
| Singapore ... ... | 44 | 10 | 18 | 17 | 22 |
| Japan ... ... | — | — | — | 7 | 11 |
| Total ... | 44 | 64 | 118 | 231 | 523 |

During the first ten months of 1913, 326 tons were exported.

The uncleaned cotton is exported principally to Singapore, where a small part is cleaned in an up-to-date ginnery. The ginned product is exported from there to Switzerland for the spinning mills.

Most of the uncleaned Palembang cotton imported into Singapore is immediately shipped to Japan. The cleaned product is used partly as a material for stuffing winter kimonos.

Uncleaned cotton is also exported from Ampenan and Pabean, in addition to Palembang, and the following quantities (in tons) were exported during 1905 and during 1909-1912.

| Ports of shipment | 1905 | 1909 | 1910 | 1911 | 1912 |
|---|---|---|---|---|---|
| Palembang ... ... | 4,082 | 5,825 | 6,089 | 4,510 | 5,502 |
| Ampenan ... ... | 140 | 831 | 904 | 657 | 686 |
| Pabean ... ... | 247 | 26 | 48 | 207 | 130 |
| Total ... | 4,469 | 6,682 | 7,041 | 5,374 | 6,318 |

The export of uncleaned cotton from Palembang and Ampenan during the year 1913 amounted to 8,380 tons. The shipments were destined for the following countries:—

| Countries of destination | 1905. Tons | 1909. Tons | 1910. Tons | 1911. Tons | 1912. Tons |
|---|---|---|---|---|---|
| Singapore ... ... | 4,469 | 5,942 | 6,136 | 4,790 | 5,472 |
| Japan ... ... | — | 693 | 904 | 584 | 846 |
| United Kingdom ... | — | — | 1 | — | — |
| Germany ... ... | — | 47 | — | — | — |
| Total ... ... | 4,469 | 6,682 | 7,041 | 5,374 | 6,318 |

From Palembang 7,903 tons of raw cotton were exported in 1913, against 5,502 tons in 1912; and 375 tons of cleaned cotton, against 523 tons in 1912.

Some years ago a modern ginnery was established in Palembang, but in proportion to the quantities of raw cotton which were still exported in 1913, this industry proved to be of little importance.

## RISULTATI DI ACCLIMAZIONE DELLA AGAVE RIGIDA VAR. SISALANA IN SICILIA.

Per il Professore Calcedonio Tropea.

A sperimentare l'acclimazione della Sisalana in Sicilia, fui indotto da quattro considerazioni: —

1° La mancanza di colture adatte a scopi industriali, in un'Isola che, tanto affine per clima, terreni, e, talvolta per condizioni sociali, alle colonie dell'Africa settentrionale, si presta certamente a molte coltivazioni di carattere tropicale.

2° La esistenza in Sicilia di estese piantagioni di Agave americana, e la sua acquisita rusticità in terre sassose ed aridissime.

3° La esistenza di notevoli superfici di terreni atti alla coltivazione dell'Agave americana e quindi, con molta probabilità, anche dell'Agave rigida var. sisalana.

4° La maggiore resa economica della Sisalana, in confronto alla specie locale.

Queste considerazioni mi fecero concludere sulla possibilità di introdurre in Sicilia la Sisalana, e di sostituirla all'Agave americana. In tal modo mi è parso di fare il vantaggio dell'agricoltore, dandogli modo di utilizzare terreni aridi e sassosi, oggi brulli perchè inetti alle comuni coltivazioni; il vantaggio dell'industriale, col fornirgli una materia tessile molto ricercata e che attualmente egli importa dall'Estero; il vantaggio della Scienza, perchè, accertata la acclimazione della Sisalana in Sicilia, viene ancora una volta dimostrata come quest'Isola possa essere considerata dal punto di vista agronomico, come un vero lembo di Africa, dove la civiltà ha già cominciato ad imprimere i primi solchi del Progresso.

Ciò quanto alla utilità immediata di tale acclimazione. Dappoichè, se la coltura riuscirà ad estendersi, come prevedo, non è lontano il giorno nel quale potranno sorgere tutte le industrie secondarie del Sisal, e specialmente quelle inerenti alla estrazione di alcool, di pasta da carte, ecc. derivanti dai residui della sfibratura.

Tralascio, per brevità necessaria all'indole di questa comunicazione, le dettagliate notizie sugli esperimenti fatti, e rimando per esse a quanto ebbi già a scrivere nel passato.[1]

Mi limito quindi a riferire su quelle conclusioni ultime, cui esse mi han condotto, e che a me sembra abbiano non solo interesse per la Sicilia, ma costituiscono dati per indurre sul possibile tornaconto di una coltivazione di Sisal nel Nord-Africa.

I periodi più opportuni ad iniziare la piantagione coincidono coi mesi di marzo o di novembre, ossia prima o dopo il periodo delle piogge. I rigetti sono da preferisi ai bulbilli, perchè fioriscono più tardi, e dànno piante meglio formate, di più rapido accrescimento e con fibre più lunghe.

La lunghezza delle foglie, durante i primi tre anni, non raggiunge il metro, epperò solo dopo questo periodo è possibile iniziare il taglio delle foglie per utilizzare le loro fibre.

Dal quarto anno in poi ogni pianta produce annualmente circa 35 foglie, mai meno di 30, la cui lunghezza varia fra m. 1·20 e 1·40. Occorrono circa 72 foglie per estrarre un chilo di fibre, in modo che, distanziando le piante di due metri una dall'altra si ha per ogni Ea. almeno una tonnellata di fibre della lunghezza media di m. 1·20.

Campionato il prodotto alla locale Società Tele Olone Canapacci, questa ebbe a stimarlo al prezzo medio di ottanta lire il quintale; donde il reddito lordo per Ea. sarebbe di lire 800, dalle quali detraendo il valore del terreno, l'ammortamento dell spese di impianto, e del fitto del terreno nei primi tre anni di passività, le spese di raccolta, di trasporto al raspatoio, l'ammortamento del raspatoio, le spese di sfibratura, lavaggio, asciuga-

[1] Tropea, C.—" Istruzioni su la coltura e l'industria della Agave rigida var. sisalana," in *Boll. del R. Giardino Coloniale di Palermo*, nuova serie, vol. i, pag. 39 a 81.

mento, imballaggio, spese che complessivamente non possono superare le lire 650, resta un utile netto per Ea. di lire 150.

E' necessario inoltre considerare che, adattandosi il Sisal a terreni di solito abbandonati, nè dovendo subire confronti con altre piantagioni, esistenti, il suo tornaconto, che a prima vista potrebbe sembrare molto modesto, riesce invece assai considerevole e tale da invogliare l'agricoltore ad iniziare la piantagione.

E' bene notare inoltre che i dati di ammortamento del raspatoio sono calcolati per una piantagione di solo 4 Ea., limitando il suo lavoro a solo 40 giorni dell'anno; che il numero delle foglie è preventivato al minimo assoluto, che non è calcolato l'utile dei prodotti secondari, che è esagerata la spesa di raccolto, lavaggio, asciugamento e imballaggio; che la resa di un chilo ogni 72 foglie è calcolata per le foglie più corte, mentre le più lunghe hanno dato perfino un chilo di fibre ogni 44 foglie, e infine che il prezzo delle fibre fu stimato su campione non perfettamente curato. E' naturale quindi che la coltivazione del Sisal debba effettivamente dare un reddito maggiore di quello da me calcolato, accrescendosi sempre più il valore di questa piantagione.

La qualità delle fibre, determinata dal suo prezzo, conclude inoltre sulla necessità di sostituire le attuali piantagioni di Agave americana, con la Sisalana, epperò tende vieppiù al introdurre in Sicilia questa piantaed a consigliarne estese coltivazioni.

Risoluta la quistione dell'acclimazione, sarebbe tutt'ora impossibile la coltura del Sisal se non fossero state costruite piccole sfibratrici, facilmente trasportabili e di costo molto modesto.

E' noto di fatto come la Sicilia, per quanto abbia estesi terreni adatti alla Sisalana, questi raramente appartengono ad unico proprietario, ovvero si trovano molto distanti uno dall'altro, per cui molto difficilmente potrebbero dar lavoro ad una grande sfibratrice, nè, del resto, la mano d'opera per una sfibratura a mano, lascerebbe alcun margine all'agricoltore, assorbendo essa sola il valore del prodotto.

Esistono attualmente macchine azionate da motore a petrolio di 3 h.p. capaci di sfibrare nelle dieci ore circa 4,000 foglie, poco voluminose e abbastanza leggere (un carro con due muli potrebbe facilmente trasportarla sui singoli luoghi di produzione) il cui costo, incluso il motore, non supera le 4,000 lire, epperò addate anche per piccole coltivazioni, come quelle che singolarmente potrebbero sorgere in Sicilia.

Nella pubblicazione che in principio do citato sono esposti dettagliatamente i dati relativi a questa industria e, anche per essa, rimando a quanto ebbi già a scrivere sul proposito.

Nulla si oppone quindi alla introduzione e diffusione dell'Agave sisalana in Sicilia, ed io mio auguro che, in conseguenza dei risultati esposti, frutto di vari anni di esperimenti, possa dal Congresso di Londra partire un voto per la istituzione di campi dimostrativi di Sisal in Sicilia, voto che il nostro Governo non potrebbe certo trascurare.

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# RUBBER.

## THE CULTIVATION OF HEVEA BRASILIENSIS IN UGANDA.

By Samuel Simpson, B.Sc.

*Director of Agriculture, Uganda.*

Hevea is by far the most popular of all the rubbers amongst the planters in this country, and it has been mainly planted along with coffee as a catch-crop. The area under Hevea only is comparatively small, but as the mixed crops of rubber and coffee attain the age of 6 or 7 years the coffee is gradually cut out, so as to leave the whole of the area entirely free for the growth and development of the rubber trees.

Para rubber grows well in height, but slowly in thickness, for two or three years, when it thickens fairly rapidly, and at 5 years old a girth measurement of 16 in. 3 ft. from the ground is common, and such trees can be lightly tapped.

In the Botanical Gardens, Entebbe, are to be found the oldest Para trees in the country, and here tapping results have proved fairly satisfactory.

Tapping was commenced on November 14, 1908, when the only 7-year-old tree was tapped along with one at 4 years old. Tapping was continued for a period of fifty-nine days, and 4·7 and 4·3 oz. of dry rubber were obtained from the trees respectively. It was then estimated that 1 lb. of dry rubber per tree could be confidently expected from Hevea in Uganda.

Further experiments were made on trees 4 years old which were tapped forty-four times over a period of ninety days, and the yield averaged 4½ oz. of dry rubber per tree, whilst in a later experiment the same trees gave

$5\frac{1}{2}$ oz. of dry rubber per tree in a period of sixty days' tapping.

In the same Gardens during 1912, 164 trees were tapped forty-one times, and the average yield per tree of dry rubber was 13 oz. The trees were presumably 8 years old, and the methods of tapping were various and entirely experimental.

The trees were then rested for nine months, and on January 1, 1913, tapping was re-started on 310 trees, which up to March 31, 1913, had been tapped seventy-one times. The yield of dry rubber per tree averaged $13\frac{3}{4}$ oz.

Two of the trees yielded over 1 lb. of dry rubber each during January, but fell off considerably afterwards.

Tapping experiments on a commercial scale were carried out last year on the Kivuvu Estate, when on an average 1,800 trees were tapped monthly for four months. The average yield per tree for that period was 5·13 oz. of dry rubber. The trees were 5 years old, and the method of tapping was one basal V cut.

During a recent visit to this estate it was noticed that the young Para trees showed no ill-effects from the tapping and were increasing in girth rapidly.

From figures supplied by Mr. Brown, the manager, it was evident that the cost of production of dry rubber on this estate was under 1s. per lb.

Some natives have small plantations of Para, and the various missions cultivated 122 acres. On March 31, 1913, European planters had 214 acres under Para only, and 2,603 acres of Para interplanted with coffee, whilst, in addition, 171 acres had been interplanted with cocoa.

During last year the acreage under Hevea has undergone great extension, as the supply of local seed is now ample for the country's requirements.

The export of cultivated rubber is still in its infancy, as during 1912-13 only 4,474 lb. were exported, and the greater part of this was obtained from rubbers other than *Hevea brasiliensis*.

## DISEASES OF HEVEA IN CEYLON.

By T. Petch, B.A., B.Sc.

*Government Botanist and Mycologist, Ceylon.*

When it is realized that more than thirty years have elapsed since *Hevea brasiliensis* first began to be planted on estates in Ceylon, it will be evident that our premier rubber tree has now successfully withstood a fairly prolonged exposure to the parasitic fungi of its new habitat. During that period it has acquired comparatively few diseases, and the majority of those have not proved serious. The total number of recorded diseases of Hevea has remained stationary for the last six years.

It is not the intention of the present paper to give a summary of the known diseases of Hevea. That has previously been done on several occasions, and, in the case of most of the diseases there is nothing to add to what has already been published. The following account will be confined to those diseases which are of practical importance in Ceylon at the present time—a limitation which excludes all leaf diseases and practically all root diseases, with the possible exception of brown root disease.

While *Fomes lignosus* (the *Fomes semitostus* of previous Hevea literature) occurs chiefly in association with jungle stumps in young clearings, brown root disease may appear at any stage and, apparently, independently of any dead wood. It is, however, much less destructive than *F. lignosus*, and as a rule is confined in each case to a single tree. But, judged by the number of cases, it is now the commonest root disease in Ceylon.

Roots attacked by brown root disease are characterized by an encrusting mass of earth, sand, and small stones bound together by fine brown mycelium. In most cases the outer layers of mycelium ultimately turn black, so that the encrusting mass appears black instead of brown. On cutting into the diseased root it is usually found to be traversed by black or brown plates, and in the case of tea the decayed wood may exhibit a honeycomb structure.

The fungus to which this disease is attributed, *Hymenochæte noxia*, was originally discovered in Samoa on bread-fruit trees. Subsequently it was found on coffee in Java by Zimmermann. In 1905 it was first recorded as parasitic on Hevea in Ceylon, and since then it has been found to attack, in the same country, cocoa, tea, dadap (*Erythrina*), *Castilloa elastica*, Caravonica cotton, camphor, *Cinnamomum Cassia*, *Erythroxylon Coca*, *Brunfelsia americana*, *Grevillea robusta*, *Codiæum variegatum*, Ceara rubber, etc. Brick has recorded it again from Samoa, where it is known to attack cocoa. *Castilloa*, bread-fruit, and *Albizzia stipulata*, as well as jungle trees; and specimens have been received from the Gold Coast on *Funtumia*.

As will be evident from the foregoing list, the fungus is practically omnivorous. Yet the actual damage in each case is usually strictly limited. Its growth in Ceylon is very slow, and if the plant first attacked is removed as soon as the disease is discovered, no further deaths occur in that spot. Bancroft records the same slow growth in Malaya. But it would appear from the records to spread more rapidly in Samoa. Instances of its slow progress when allowed to run unchecked have been noted in the case of both tea and rubber; in one instance three Hevea trees in a line were killed in four years.

The fungus apparently spreads from one plant to the next only if the roots are in contact, but even this does not generally occur unless the dead plants are allowed to remain for a fairly long time. An exception to this is general in the case of Grevilleas in tea plantations, where the Grevilleas are first attacked; in such cases a number of tea bushes may be killed before the Grevillea dies. Anstead has recorded an experiment in which a diseased root was buried in contact with the roots of a healthy tree, with the result that the latter was infected and died.

The experiment of replanting a tree of the same species in the place where one had just died from brown root disease was tried at Peradeniya about four years ago. The "supply" is still healthy. It would appear that replanting can be carried out immediately, provided that all dead wood has been removed.

The disease has been found to originate on jungle stumps in one instance in tea. In another case it was common on Hevea, planted among cocoa, where the intermediate rows of cocoa had been cut out to make room for the Hevea. It may, indeed, be said that a large proportion of the cases of brown root disease on Hevea in Ceylon are on old cocoa land. On new clearings in Ceylon it has not been found possible to trace the disease to jungle stumps. Bancroft, however, states that in Malaya each case of infection has been referable to the presence of a jungle stump.

But in the majority of its occurrences in Ceylon, other than on Hevea, brown root disease has killed plants in old-established cultivations where no jungle stumps existed. This is notably the case in tea and Grevillea. In such cases only an infection by means of spores appears possible. Here we are met by a difficulty. As a rule *Hymenochæte noxia* does not produce spores, or, indeed, a fructification. When the fungus has grown up the tap-root and reached the surface of the soil, where it should begin to form its fructification, it usually ceases altogether to grow in that direction. In several cases in Hevea, tea, and cocoa, stumps of diseased plants have been left undisturbed in the hope that they would develop the fructification, but all have ultimately succumbed to white ants without doing so, though some have persisted for four years. Sometimes the fungus does ascend farther up the stem, forming a brown velvety coat, but as a rule this is present only in small patches. If the root is dug up, planted in a pot, and kept under favourable conditions for the development of the fungus no greater success results. Experience in Malaya would appear to agree with this. Bancroft states that the fungus does not apparently fruit in abundance in that country; he had only been able to find a single fruit on camphor, and that a badly developed specimen.

Recent investigations into brown root disease on

Grevillea and tea have furnished suggestions which may explain this spread of the disease to fresh centres in the apparent absence of any fructification and spores, but these have not yet been completed.

Of the stem diseases, "pink disease" and "dieback" are of minor importance in Ceylon. The former is apparently exceedingly common in Java, where it has been fully investigated by Zimmermann, Zehntner, and Rant.

Pink disease is caused by *Corticium salmonicolor*, B. and Br. (*Corticium javanicum*, Zimm.). The fungus is widely distributed through the Eastern tropics, but the damage caused by it varies considerably. In Java, Dr. Rant has enumerated 141 species of wild and cultivated plants which are known to be attacked by it; but on the mainland, in the Federated Malay States, it appears to be scarcely known. In Ceylon and India the conditions are reversed, for it has caused much loss in South India, but very little in Ceylon. It occurs on various plants in Ceylon up to an elevation of 5,000 ft., but only sporadically. To the list of hosts given by Rant, Ceylon can add camphor and *Polyalthia longifolia*.

In Hevea the disease usually attacks the main stem at or immediately below a fork. The bark dies and splits away from the wood, sometimes all round the stem, sometimes over a limited patch. In the former case the tree is ringed and the crown dies; in the latter the dead bark scales off and an open wound is left. The difference is probably due to weather conditions.

The fungus makes its appearance on the diseased bark in three forms. In one form minute pink cushions are produced in small cracks in the bark; this form has been described as a different fungus (*Necator decretus*, Mass.). In the early stages of this form the minute cracks resemble large lenticels, and this, before the pink cushions appear, has been styled the "measles" stage. In a second form the hyphæ of the fungus extend over the surface of the bark in long, silky strands which may coalesce and form a thin shining plate of fungus tissue. The third form is the fully developed fructification, a thin pink sheet overlying the bark, and ultimately splitting into small fragments by lines more or less at right angles to each other.

In Ceylon pink disease usually makes its appearance towards the close of the rains of either monsoon. As a rule, treatment is confined to pruning down the tree below the diseased part. In South India, spraying the forks of the trees with Bordeaux mixture has been found to prevent attack.

The term "dieback" might equally well be applied to some cases of pink disease, since in the latter the whole of the crown above the diseased part of the stem may die. The name has, however, become associated with a different disease, in which the whorls of branches die in succession from the top downwards, owing to the growth of a fungus down the main stem.

The chief agent in dieback—that is, the fungus which kills the main stem—is *Botryodiplodia theobromæ*. It occurs throughout the tropics, but is especially common in cocoa-growing countries. As usual, it has received a number of names, among which may be noted *Lasiodiplodia theobromæ*, *Lasiodiplodia nigra*, *Diplodia cacaoicola*, *Diplodia rapax*, *Botryodiplodia elasticæ*. Though numerous diseases have been attributed to this fungus, it is, in general, a saprophyte. It develops in abundance on plucked cocoa pods, felled Hevea stems, stems of Ficus, etc., though these may have been quite healthy when living. It is only necessary to gather cocoa pods or to fell a sound Hevea stem and to leave it to dry, either under cover or exposed to rain, to obtain this fungus. In about a week the material will be covered with masses of spores in the form of a black powder. If the material is somewhat dry the spores may be white at first, turning black subsequently.

*Botryodiplodia theobromæ* can, however, function as a wound parasite, and in that capacity it may attack Hevea and cocoa. In the case of Hevea, once it has obtained entrance to the stem it travels rapidly downwards, and may kill the tree completely within four or six weeks. The wood of the stem is blackened by the hyphæ of the fungus, the cambium is converted into a brown slimy layer, and the bark splits away from the wood and dries up.

As to the circumstances in which the fungus is able to enter the stem there is some difference of opinion. Bancroft, as a result of his experiments, concludes that it is simply a wound parasite, *i.e.*, that it can enter through any wound, or, at least, one which exposes the wood. His experience in Malaya differs from that in Ceylon, in that dieback has been found to begin there from the stubs of pruned branches. In Ceylon that has not yet been observed, though pruning has on many estates been carried out on an extensive scale. And attempts to infect healthy Hevea saplings, 1 or 2 years old, with the spores of Botryodiplodia have failed. The most remarkable fact, however, which tells against the theory that the fungus is a simple wound parasite is that it has not yet been found to attack the tapped surface, even though the wood has been exposed by bad tapping.

It is noteworthy that *Botryodiplodia theobromæ* follows soon after the attack of another fungus in many cases, and it is because of that faculty that so many diseases have been attributed to it. It develops rapidly on Hevea pods, or Hevea cortex, previously attacked by *Phytophthora Faberi*, and it similarly follows pod disease and canker of cocoa. Observations in Ceylon would seem to indicate that, in general, Botryodiplodia follows a previous fungus attack, and that in the case of dieback of Hevea it obtains an entrance through dead green shoots.

The green shoots of Hevea frequently die, and this effect may be produced by several agencies. Wind, over-tapping, shade, or excessive rainfall account for it in some cases, while it may be brought about also by a definite fungus attack, as by *Gloeosporium alborubrum*, *Phyllosticta ramicola*, or the canker fungus, *Phytophthora Faberi*, following an attack of pod disease. So long as the green shoots only are concerned this effect is negligible, but it may be followed by an attack of *Botryodiplodia theobromæ*, which kills the tree. Observations in Ceylon would appear to show that when the Botryodiplodia attacks the tree the green shoots have been previously killed by Gloeosporium.

The abundant development of Botryodiplodia on felled Hevea stems provides a reason for burning all Hevea debris when thinning out. It should, however, be stated that, though the disease is extremely rapid in its action when it does occur, it has not proved so dangerous as was at first anticipated. The idea that an exudation of latex from the upper parts of the stem is a symptom of this disease has been discarded.

Bancroft has discovered, on material attacked by *Botryodiplodia theobromæ*, an ascigerous fungus, *Thyridaria tarda*, which he considers is the higher stage of the former. The disease is, therefore, frequently referred to under the latter name.

The most serious disease of Hevea known at the present time is canker, not only because it may kill the tree, but because, even when the attack is slight and the tree recovers, the result of the treatment may be such that the tree cannot be tapped again for several years. As in the case of cocoa, the term "canker" which has been applied to this disease is misleading, since in most cases no canker, *i.e.*, no open wound, is produced. If the tree is killed outright the bark remains quite smooth and unbroken.

This disease was first recorded in Ceylon in 1903. Since then it has been found in South India, Burma, and Java. As it is identical with cocoa canker, it will no doubt ultimately be found to occur in all cocoa-growing countries. According to the present records it has not been detected in Malaya, but several of the accounts of Hevea disease in that country suggest that it occurs there, but has not been recognized as such.

The fungus which causes the disease (*Phytophthora Faberi*, Maubl.) has been found to attack every part of the tree except the leaves. It is responsible for the rot of the pods, when, in a wet season, the fruits turn black and do not dehisce, but remain for a long time attached to the branches. From the fruits it often passes to the green shoots and kills them back, or it attacks the leaf-stalks and causes extensive defoliation. The attack on the leaf-stalk is usually indicated by the appearance of a dark brown or blackish ring on the stalk, after which the leaf disarticulates. An outbreak of pod disease is frequently followed by general recrudescence of stem canker, and there appears to be no doubt that reinfection of the stems takes place largely by means of spores from the diseased pods.

The external signs of canker on the stem are at first very slight; the bark may be a little darker over the diseased spot. In more advanced stages a red-brown liquid may exude, which dries in small streaks on the bark. But the disease is unmistakeable as soon as the bark is scraped. Then, instead of a green layer underlying the corky bark, one meets with a black layer, and if that is cut away the cortex, instead of being white, or yellowish, or cleared, is found to be a dirty red, which rapidly darkens to claret colour. If the whole of the diseased cortex be laid bare it will usually be found to be bordered by a black line. There is an earlier stage than this, in which the diseased cortex is not claret-coloured. When first attacked it is greyish-yellow, and appears sodden. But even in this stage it is bordered by a black line, and the layer immediately beneath the outer brown bark is black.

Cankered bark has a peculiar smell which soon attracts boring beetles, particularly a small brown beetle about the size of a shot-hole borer. Numerous specimens of damage to Hevea supposed to be caused by borers are sent in for examination, but in practically all cases it turns out that the tree has been first attacked by either canker or pink disease.

The disease begins in the outer layer of the cortex and gradually penetrates to the cambium, at the same time extending up and down and round the stem. It may penetrate completely through the cortex, and spread so rapidly that the tree is dead in a few weeks. In such a case the bark is usually smooth and unbroken, and does not exhibit any of the phenomena which pass under the name of canker in other trees. There is generally a copious exudation of the brown liquid, and the tree is soon riddled by borers.

Canker at the collar of the tree is equally disastrous. In that situation the disease has usually obtained a good hold before it is discovered. It kills the cortex all round the base of the stem, along the lateral roots, and down the tap root.

At the present time in Ceylon the general course of the disease is less serious than in the cases just referred to. In the great majority of cases the fungus does not penetrate completely through the cortex, but stops after advancing partly through, and the diseased tissue is then cut off from the surrounding healthy cortex by a layer of cork cells. The patch of diseased tissue dries up, and forms a scale which can be easily detached. Underlying this scale one finds healthy laticiferous cortex. The scales are frequently lenticular, and if the fungus has penetrated to the wood in the middle of the patch, they leave a hole extending to the wood when they are removed.

This difference in the course of the disease is probably to be attributed only to climatic conditions. There does not appear to be any other reason why the disease should cease to be active. In a very wet season the more serious form of the disease would probably be the most common.

Formerly it was advised that all cankered cortex should be cut out. Owing to the damage caused by that treatment on the exploitable part of the tree (canker most often occurs within 4 ft. of the ground), it has now been modified in imitation of what so frequently occurs naturally. The diseased part is scraped or cut away so as to remove most of the cankered bark, the cutting being continued until latex begins to appear in minute drops. This is a sign that the limit of the diseased part is being reached, as the cankered cortex does not yield latex. The remainder of the diseased cortex is then left to dry up and scale out. Of course, if the disease has penetrated to the wood the whole of the cankered cortex is cut out.

Old scales of canker, where the disease has not been discovered prior to the scaling out, should be removed. Canker often begins anew behind these scales.

Spraying with Bordeaux mixture has been advised as a preventive of canker, but hitherto the disease has not been thought sufficiently serious to warrant its adoption. Unfortunately, as is well known, the presence of copper or copper salts in rubber tends to produce tackiness, and it would therefore appear that Bordeaux mixture cannot be applied to trees in tapping. It has been recently stated that there is no reason why Bordeaux mixture should be recommended, since lime-sulphur mixture is free from that objection and equally serviceable.

But the results of all experimental work available prove that lime-sulphur mixture is not toxic to Phytophthora, Whether the *Phytophthora Faberi* will prove an exception remains to be demonstrated. Experiments in spraying with Bordeaux mixture were carried out on twenty-five trees at Peradeniya, the rubber subsequently collected being made up in biscuits. The amount of copper in the biscuits made immediately after the spraying was very small, and none of the biscuits made during the next six months turned tacky. It is intended to repeat this experiment, and it is hoped that other experiment stations will do the same.

Almost as serious as canker from the tapping standpoint is the formation of nodules or burrs on the stem. As far as is known at present, these are not attributable to either insect or fungus agency. They occur on untapped as well as on tapped trees, and are most numerous on trees which have been tapped with a pricker. The lower part of the stem may become thickly covered with large excrescences, so that any regular tapping is impossible.

The commonest form of nodule in Ceylon begins as a small sphere or cylinder of wood in the middle of the cortex. Its nucleus consists of a small group of brown cells. A cambium, quite distinct from the main cambium of the stem, develops round this group of cells, and then proceeds to build wood round them. As the nodule increases in size it develops points directed inwards, which ultimately unite with the main wood of the stem. These nodules are easily removed when they are small before they have become united to the main wood.

If several of these nodules arise close together they may fuse and form a plate. But the formation of plates often takes place in a different manner. Instead of a group, more or less spherical or cylindrical, of brown cells, the nucleus of a plate is a sheet of such. These sheets may occasionally be met with in the middle of apparently healthy cortex; they are pale yellowish-brown, sometimes continuous for several inches, but often interrupted here and there to form a netted or perforated plate. If a cambium is developed round such a brown sheet a plate of wood is produced. These plates are distinguished from those introduced from small nuclei by their enormous extension as compared with their thickness. They may be 2 or 3 ft. in length, while only about $\frac{1}{8}$ in. thick.

The cores of wood which form the bulk of the nodule vary, according to the size of the latter, from spheres the size of a pea to roughly spherical lumps about 4 in. in diameter, or plates up to 4 or 5 ft. long and 1 ft. in breadth, which completely cover one side of the stem. The cortex which overlies large nodules usually splits. On badly affected trees a crop of small nodules is frequently found surrounding the old.

Nodules are easily removable in their early stages. They are then embedded in the cortex, and shell out readily, leaving a layer of laticiferous tissue overlying the main wood of the stem. The removal of large nodules usually entails the destruction of this underlying laticiferous tissue and the consequent production of a large open wound.

The cause of these nodules has not yet been ascertained. They have been attributed to dormant buds, injuries caused by carts, etc., and previous attacks of canker, none of which theories can, if true, have any but a very limited application. In the vast majority of cases there is no evidence of anything of the kind. Bateson has recently announced that the brown cells include latex tubes, and this has been confirmed by Mr. G. Bryce, who is now investigating this problem in Ceylon. It is hoped that the investigations now in progress will throw further light on the subject.

Another phenomenon which has not yet been traced to fungus agency is the decay of the tapped cortex; that is, the thin layer of original cortex which is left overlying the cambium. This decay occurs in wet weather, usually in the North-east Monsoon, October-November. It is especially common on trees which are tapped for the first time during those months. The decaying patches usually run vertically, and first appear on the exposed cortex within an inch of the tapping cut. Narrow sunken vertical lines are seen above the tapping cut, and if the thin layer of original cortex is cut away a narrow black streak is found extending into the wood. If the weather continues wet the black patches extend upwards and downwards, and at the same time increase in width; and if a number of them have arisen close together they may coalesce, so that a wide horizontal strip of renewing bark is destroyed. More usually, however, a number of parallel vertical wounds are formed. When dry weather sets in this decay stops and the wounds begin to heal up; but the renewal is, in any case, rough, and, where several wounds have coalesced, so much cortex is destroyed that renewal cannot be completed for many years.

This decay of the tapped surface is often attributed to bad tapping. It is, however, distinguished by the fact that the wounds are vertical, whereas tapping wounds are usually horizontal. Moreover, tapping wounds extend to the wood, while in the case now discussed a thin layer of dead cortex is left overlying the wound, and may be detected on close examination six months afterwards.

Inoculations with various organisms found in these decaying patches in Ceylon have failed to reproduce this effect. In Java it is attributed to canker (*Phytophthora Faberi*), but we have not been able to obtain any evidence of that.

A method of treatment which is said to have proved successful in Java is now being tried in Ceylon. As soon as the narrow vertical lines are observed the tree is put out of tapping. The affected tapping surface is then washed every four or five days with a 50 per cent. solution of carbolineum plantarium. According to the reports from Java, the tree can be tapped again after about four weeks. If a large patch has decayed, the dead cortex is cut out before treatment with carbolineum.

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## ON SOME ANIMAL PESTS OF THE HEVEA RUBBER TREE.

By E. Ernest Green, F.E.S., F.Z.S.

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I propose in this paper to confine my remarks to the animal pests of the Hevea rubber tree, but of these I can speak (from actual experience) of such only as occur in Ceylon, where, during a residence of over thirty years, I turned my attention to entomology in general and economic entomology in particular.

The plantation rubber industry is one of comparatively recent development. In Ceylon there are few rubber plantations of over ten years' standing, and I think that I am correct in stating that Ceylon planters were among the first—if not the first—to give serious attention to the systematic cultivation of this product.

General experience teaches us that an introduced plant, and especially one that may be described as a forest tree, usually commences its career free from pests of any kind, unless such have been introduced with it. But gradually, as time goes on, it acquires a fresh series of enemies, the number of which is likely to increase year by year. Certain insects that are more or less omnivorous will be the first to attack the new plant. Others that have been subsisting upon allied plants of older standing in the country will find that the newcomer will serve their requirements equally well, and possibly better, inasmuch as they will tap a large source of food supply with few rivals in the field. A species that may have been of no economic importance in its original habitat may, under the stimulus of new and favourable conditions, develop into a serious pest. It is this possibility that makes it dangerous to neglect any pest, however trivial it may appear to be at the time.

I think there is no doubt that the Hevea tree is to a large extent protected from insect attack by the copious flow of viscid latex that exudes from the slightest wound to the cortex. Small insects that rashly try to penetrate the stem are either engulfed in this fluid or repelled from further attempts in that direction. Dr. Wurth, experimenting with *Xyleborus coffeæ* (one of the so-called "shot-hole borers") in Java, placed some of the beetles on a green Hevea twig, and has described the results as follows: "Most of the beetles began boring at once, but the hole was scarcely half a millimetre deep before a drop of latex appeared, which coagulated, and thereby stuck the beetle fast and killed it. In a short time there were more than thirty beetles fast, and looked as though they had been caught on a limed stick."

Sucking insects, however, drawing their nourishment from the sap of the plant, are able to reach their objective without interference with the laticiferous vessels. Coccidæ, for instance, possess hair-like haustella which they are able to introduce into the tissues of the plant, and to guide in any desired direction to a distance considerably longer than their own bodies.

This comparative immunity does not extend to the foliage of the plant where the latex is greatly reduced in quantity. Nor is it proof against the larger animals. Indeed, the latex itself appears to be the principal attraction in some cases. It might be thought that a fluid which, when coagulated, is transformed into solid rubber would seriously inconvenience the internal economy of any animal. But this does not appear to be the case. Possibly the digestive fluids prevent coagulation or alter the substance in such a manner as to render it digestible. I have been credibly informed, though I am not in a position to vouch for the fact, that even man himself may imbibe considerable quantities of rubber latex with impunity.

By far the greater proportion of insects that are known to attack the Hevea tree are really secondary pests, *i.e.*, pests that follow upon a diseased or unhealthy condition of the tree resulting in a diminution or complete cessation of the protective latex. In this connection I speak of the latex as "protective," not that I wish to assert that this is its sole or even chief function. I am aware that several theories have been propounded to explain the function of the laticiferous system. It is considered by some authorities to be of an excretory nature; while others believe that it is in some way concerned in the storage of reserve food for the plant. But I do maintain that it has a distinct protective value.

The fact that many of the recorded enemies of Hevea are secondary pests does not lessen their importance. They may complete the destruction of a tree that would otherwise have recovered from the original disease.

It must also be understood that some of the various insects recorded as pests of Hevea are probably casuals. Every insect that is found resting on the stem of a rubber tree, or even lurking in the neighbourhood, is looked upon with suspicion, and is liable to be condemned without further investigation. Our catalogue of rubber pests, comparatively small as it is, would be considerably reduced were the names of all such casuals eliminated.

## Mammals.

Animal pests of Hevea are to be found amongst both the higher and lower orders of the animal kingdom—the vertebrates and invertebrates. Amongst the former must be reckoned such beasts as elephants, cattle, deer, goats, pigs, hares, porcupines, and rats.

In Ceylon, stray cattle and goats owned by native neighbours are a grievous nuisance, and are responsible for much damage to young plantations. These animals, having no proper grazing ground, are turned out at night to forage for themselves. They browse along the road-sides (to the inconvenience and danger of motorists) and wander into the neighbouring clearings, where they will experiment with any plant that comes in their way. Besides injury to rubber nurseries by trampling over the seedlings, they will break off, or even pull up, the young plants, and will devour the foliage of well-established trees.

Wild deer from the jungles will invade a clearing and behave in very much the same way as their domestic relatives. They have also been known to tear off strips of bark, apparently to refresh themselves with the resulting latex. The only adequate defence against these larger nocturnal marauders lies in the liberal employment of barbed wire, with which all properly conducted plantations should be entirely enclosed, entrance to the fields being preferably dependent upon rough stepladders. Gates are too apt to be left open by careless pedestrians.

In the Belgian Congo, goats, antelopes, and wild pigs invade the plantations and strip the bark from Hevea trees.

Barbed wire is of no use against the smaller mammals, amongst which the porcupine may be reckoned one of the most troublesome enemies of the rubber planter. This animal simply revels in the succulent bark of the rubber tree. The amount of damage that a single porcupine, coming night after night, can effect is astonishing. I have seen the bark more or less completely stripped from the stems of three- and four-year-old trees, from ground level up to a height of about 2 ft. If, as is often the case, the injury extends all round the stem the tree naturally dies, the circulation of sap being completely interrupted. If a small area of bark on one side escapes destruction the tree may continue to struggle along in a half-starved condition, but will seldom fully recover. Such invalid trees are only taking nourishment that might be more usefully employed by their healthy neighbours, and are best out of the way. They also form a nidus for wood-boring insects of all kinds.

The porcupine is one of the wiliest of animals and most difficult to circumvent. You may sit up with a gun night after night, but the animal keeps out of your way, and chooses some other spot for his depredations. He laughs at any ordinary trap, and has a keen nose to detect poisoned baits. The Cingalese villager has more success He is an adept at setting spring guns, his inborn knowledge of tracking enabling him to place these in the best possible positions. A porcupine that had been ravaging my garden for weeks, and that had defied all attempts upon its life, fell a victim the very first night after one of these native sportsmen had been called in. But spring guns are dangerous weapons to play with, and many regrettable accidents have occurred through their use.

Hares have been accused of biting off the heads of young rubber plants. Damage of this kind is usually confined to nurseries, and may be prevented by enclosing the nursery plots with wire netting.

The bandicoot also is a troublesome pest. This huge rat, with its powerful chisel-like teeth, will gnaw through a rubber stump an inch or more in diameter. An example of its work that came under my observation was a young Hevea tree, measuring 4½ in. in circumference, which had been completely severed at the base, the exposed parts of the wood showing the characteristic marks of the animal's teeth very clearly. The correspondent who sent me this specimen (which was apparently one of many) gave me the following account of the *modus operandi* of the animal: "The bandicoot always scoops out a hole at one side of the rubber plant, and gnaws away the tender root as deeply as possible—that is, as far down the root as he can get—and he invariably gnaws the woody part of the root. The plant then falls to the ground, when the animal can get at the tender bark above." From this account it would appear that the animal deliberately fells the tree in order to feed upon the tender bark that would otherwise be out of its reach. Danysz's virus was tried without any visible result.

On some plantations, where porcupines and bandicoots are prevalent, it has been found necessary to protect each individual tree by wrapping wire netting round the base of the stem—an expensive remedy. With rubber prices at their present low level it is necessary to cut down expenditure by every possible means, and some cheaper method of protecting the rubber stems would be welcomed. Various patent mixtures have been tried without success (some of them with positive harm). Possibly the following extract from "The Yearbook of the United States Department of Agriculture" (1909) may afford a solution of the difficulty: "During the last year the lime-and-sulphur wash, which for a number of years has been employed to prevent damage to trees by the San José scale, was tried with great success in several localities as a protection for orchard trees against the attacks of rabbits. The remedy is cheap, and, as a rule, a single treatment in the fall appears to protect trees for the entire winter." The lime-and-sulphur mixture may be prepared by boiling together 3 lb. of quicklime, 3 lb. of flowers of sulphur, and 6 gallons of water until the amount of the liquid is reduced to 2 gallons. For spraying the foliage of plants this mixture is diluted with 100 parts of water, but, as a protection against rats and porcupines, it should be applied as a paint of about the density of whitewash.

Rats and mice must be included in our catalogue of pests, inasmuch as they occasionally dig up and carry off seed in newly planted nurseries to feed upon the oily kernels. They may also be troublesome in clearings planted with seed at stake. Mr. R. Dupont, writing from Seychelles, informs me that rats give trouble in those islands by eating the bark of a considerable number of seedling plants.

Wild pig have been known to raid the nursery beds for the same purpose. Both wild pig and hares are said to do some damage by destroying seedlings in the neighbourhood of jungle in Java. In places where these animals are numerous extra attention must be paid to the fencing. Barbed wire must be reinforced with strong galvanized wire netting.

I am indebted to Mr. H. C. Pratt for some valuable notes on pests of the rubber tree in the Federated Malay States. In addition to the animals already mentioned, planters in Malaya have to contend with wild elephants and monkeys. Of the former Mr. Pratt writes: "Elephants have caused considerable damage in Perak, moving in herds and doing their work at night. As a general rule, on well-kept plantations they do not enter the estate very far, keeping along that portion bordering the jungle. They pull up young trees up to 2 years of age and eat the roots, particularly the tap root. If an estate is allowed to go back and become overgrown with secondary jungle they will destroy most of the rubber. The only remedy is to organize a proper drive, which is now being carried out by the Government."

The same observer remarks that the damage caused by monkeys is purely wanton. "They enter an estate, and break off the young shoots and small branches of younger trees and then clear back to the jungle. No efficient remedy is known."

## Molluscs.

Coming down in the scale of life, I must record the objectionable habits of certain Molluscs—species of slugs. These creatures were first brought to my notice in 1905, when specimens were submitted to me with the complaint that they frequented recently tapped Hevea trees, and imbibed the latex as it oozed from the cuts. This habit resulted in an appreciable diminution of the scrap rubber that could be collected after tapping. It seemed hardly credible at that time that any animal could digest liquid rubber. But some of the living slugs were provided with a saucer of rubber milk, and quickly proved the truth of the assertion by commencing to lap it up. One of them drank for about ten minutes. It is quite conceivable that many pounds of rubber may be lost in this manner. The fact that the slugs suffered no inconvenience from this diet lends colour to the theory that Hevea latex contains no rubber as such, but that the caoutchouc is elaborated only at a later stage—during the process of coagulation. The digestive juices of the animal possibly prevent this elaboration. Little more was heard of this slug for several years, when it reappeared—in a different *rôle*—as a serious pest of young rubber trees by systematically eating off the growing points. When the terminal bud is destroyed the plant sends out a series of fresh shoots immediately below the point of injury. These, in their turn, are eaten off, and fresh efforts are made by the plant, only to be foiled every time by the slug. The result is that growth is completely checked so long as the slugs are about. If the damage is allowed to continue a permanently stunted habit may be induced.

The particular slug that is responsible for this damage in Ceylon has been identified as *Mariælla Dussumieri*. Its habits are nocturnal. During the daytime it secretes itself under clods of earth, dead leaves, amongst grass and weeds, or wherever it can secure shade and damp. It comes out at night and wanders in search of food. The same slug has been observed to feed upon renewing bark, especially in sheltered situations. The animal is of a yellowish-brown or olivaceous colour, usually mottled with dark blotches. It belongs to the group that has a thin shell concealed beneath the so-called "mantle." The specimens that came under my observation measured about 3 in. in length; but in India, where it also occurs, the species is said to attain a length of 8 in.

An undetermined slug of somewhat similar habits has been observed in the Straits Settlements, where it is accused of gnawing off the skin of seedling plants and also of injuring the foliage by eating the green parenchyma and the epidermis, leaving only the skeleton of the leaf. It attacks also older plants, nibbling the bark and biting away the buds as they appear.

Professor Newstead found a large flat slug (*Veronicella virgata*) injuring the foliage of Hevea plants in Jamaica.

Mr. Wammerman, Entomologist to the Department of Agriculture, Buitenzorg, Java, reports that slugs (*Parmarion* sp.) are found drinking the latex on rainy days, both in Java and Sumatra.

Measures against injury by slugs must be principally preventive; but the collection and destruction of the animals themselves should not be neglected. Traps, consisting of damp sacking, plantain leaves, etc., can be laid on the ground beneath the trees to provide shelter for the slugs during the heat of the day. These traps should be examined systematically early each afternoon, and the slugs collected and dropped into a can of salt water. By searching the stems of the trees with a lantern just after dark the ascending slugs may be intercepted and destroyed. Poultry, especially ducks, geese, and turkeys, are very useful assistants in the work of destruction. They feed readily upon the slugs, and will search amongst the grass and rubbish, and capture many individuals that would otherwise escape observation. The most important of preventive measures will be to keep a clear area of bare soil (swept clean of all rubbish) around each tree. There are various substances that may be spread on the ground to act as a deterrent against the passage of the slugs, such as lime and soot. But these soon lose their efficacy in rainy weather, which is exactly the time when the slugs are most active. They depend, for their efficient action, upon their caustic and desiccating properties respectively, both of which are lost after exposure to rain. Moreover, these slugs have the power of secreting copious quantities of mucus, from a special slime gland at the extremity of the body, which assists them to rid themselves of the obnoxious substance. Cinders, owing to their prickly surface, are a more efficient protection. Although the slug is provided with eyes, these organs are of a rather rudimentary character, and can be of little or no assistance to the animal in its search for food. Scent is almost certainly the guiding sense. Consequently, a protective barrier of some strongly smelling substance is more likely to turn them aside from their objective. A very effective deterrent can be made by damping sawdust with crude carbolic acid or phenyl. Either of these substances may be spread on the ground round the base of the tree to be protected. Another plan is to tie cylinders of freshly tarred paper round the stem of each tree. The paper should be tarred on the outside only, and its lower edge should be covered up with earth to prevent the slugs from creeping beneath the paper. Professor Newstead, in his report on the West Indian slug of similar habits, recommends girdling the trees with cotton-wool. This may be effective while the wool remains fresh, but the first tropical shower would reduce it to a pulpy mass that would present no difficulty to the ascent of the slugs. A more effective girdle may be contrived with rough coconut fibre steeped in coal tar.

## Insects.

We now come to the class *Insecta*, which furnishes by far the greater number of the pests with which we have to deal. The several orders will be taken separately.

*Orthoptera.*

Various grasshoppers are accused of nipping off the young seedlings in the nursery beds. Specimens submitted for examination proved to be immature Acridians, too young for identification.

The "spotted locust" (*Aularches militaris*) occasionally appears in enormous numbers in certain parts of Ceylon, and attracts attention by defoliating various trees planted as shade for cocoa. Fortunately, it does not often directly attack cultivated products, but an instance has been reported of partial defoliation of young rubber plants. *Aularches militaris* is a gaudily coloured insect and can scarcely escape observation, with its yellow-spotted wings and brilliant red-and-black body. This locust has the habit of congregating in vast numbers at certain spots to deposit their eggs. In one such patch, about 4 yds. square, I found the insects completely covering the ground to a depth of 3 or 4 in. The soil beneath them was closely pitted with holes, each about 3 in. deep and ½ in. in diameter. In these holes were masses of eggs enclosed in a frothy covering. This habit affords a convenient opportunity for taking action against the pest. When the locusts are crowded together on these breeding grounds they may be collected and destroyed with the greatest ease (as they make no effort to escape). The simplest method is to sweep them into sacks, which may then be sunk under water until the insects are dead. Bags made of coir matting are most suitable, as they admit the water more readily. A trial bag filled at one of these places of assembly was found to weigh 106 lb. As a single insect weighs, on an average, just ⅛ oz., this bag must have contained about 12,800 individuals, allowing 6 lb. for the weight of the bag. From this one spot twenty such bags could have been filled without difficulty. After repeatedly clearing away and destroying the insects until they cease to assemble there, the ground on the immediate spot and for a short distance all round should be broken up to a depth of 6 in. and quicklime turned in. This will ensure the almost complete destruction of the brood. The mere breaking up of the earth would probably of itself prevent the greater number of the eggs from hatching out by exposing the egg masses to the drying action of the air and to the attacks of birds and predatory insects, such as ants and beetles, which would readily feed upon them. For the smaller species, poisoned baits, composed of bran mixed with syrup and arsenic, may be laid in the area to be protected.

The Economic Biologist in British Guiana (Mr. G. E. Bodkin) has recorded an Acridiid (*Tropidacris cristata*) as destructive to the foliage of Hevea. *Zonocerus elegans* and *Z. variegatus* are said to play the same part in the Belgian Congo.

From the Straits Settlements we have records of three crickets that are said to injure rubber plants. *Brachytrypes achatinus* saws seedlings right through, leaving a stump 1 to 3 in. high, and carries off the tender shoots to its burrow. The same species is reported from the Federated Malay States and Sumatra, in both of which countries it is accused of attacking Hevea. *Gymnogryllus elegans* is said to behave in the same manner as *Brachytrypes*, and a species of *Cyrtacanthacris* "chews off the tips of Para rubber plants at Singapore." The insects can be brought to the surface and destroyed by pouring dilute phenyl into their burrows.

In Java a locust (*Cleandrus* sp.) sometimes splits the young stems of Hevea for the purpose of depositing its eggs in the crevice so formed.

### *Isoptera.*

Injury to Hevea in Ceylon by termites is not very serious. Here they are mostly secondary pests. I have examined, at various times, small plants of Hevea, the death of which has been attributed to the so-called "white ants." These insects have been found at the tap roots, the cortex of which has certainly been devoured. In other plants the collar has been the point of attack. Older plants, and even well-established trees, have been found riddled by termites, the insects (sometimes *Termes obscuriceps*, at others *T. redemanni* and *T. Horni*) being taken apparently "in flagrante delicto." But I have always had grave doubts as to the part the termites have played in the injury. The species concerned are mainly fungus-feeders. They attack dead and diseased wood and vegetable tissues directly such material has been invaded by the mycelium of any fungus. In my experience, sound wood or healthy plants are seldom if ever attacked by any of the three species that I have mentioned. In every case of injury to rubber plants or trees that I have examined there has been indubitable evidence of previous invasion by some parasitic or saprophytic fungus.

A single instance of a colony of *Eutermes inanis* inhabiting the hollow stem of a rubber tree has come to my notice. The insects were devouring the wood inside, but left the living exterior parts alone. The original stem of the tree had been broken off by the wind, and several secondary stems had been thrown up from the stump. The termites were occupying a cavity in the old stem at the base of the new growth. At my recommendation the nest was scooped out, and the cavity was flooded with naphthalin dissolved in petrol. This treatment proved successful, and the termites vacated the tree.

The common mound-building termites (*Termes redemanni* and *T. obscuriceps*) sometimes construct galleries and screens of earth over the stems of living rubber trees, but this need cause no alarm if the tree is sound and healthy. They merely eat off the functionless dead outer bark, leaving the stem smooth and clean. As soon as they have cleared away the dry outer bark the insects will desert the tree of their own accord. But if their presence on the stem is considered undesirable, it may be prevented by sprinkling the soil around the base of each tree with a mixture of refuse petroleum and water, about 1 part of oil to 20 of water.

The evidence against the notorious *T. gestroi* is of a different nature. This species does not occur in Ceylon, and its work has not come under my direct observation; but it is a serious pest in the Federated Malay States, and in Borneo, Sumatra, and Java. Mr. H. C. Pratt, Government Entomologist, F.M.S., and Mr. Towgood, of Kuala Selangor, have given us some valuable memoirs on the subject, and it is to their writings that I am indebted for my information.

It appears that *T. gestroi* is chiefly dependent upon dead and decaying timber for its maintenance, but that—from these centres—it will extend its ravages to living trees of certain species, of which Hevea is, unfortunately, one. Even in such cases it attacks only the inert heart-wood, hollowing out the larger roots and the base of the stem, but leaving the functioning outer tissues intact. Damage to the tree is consequently the result of a weakening of its natural support, leaving it powerless to resist any external strains. Affected trees are broken off or overturned by the slightest excess of wind pressure. The only fact that lends some supposition to a theory of primary infection by fungus is that a certain selective action appears to occur, individual trees being neglected in the midst of thickly infested areas. But against this suggestion is the statement that the bark and functioning tissues of the tree remain healthy, even when the heart-wood has been more or less completely destroyed. The extent of the damage that can be effected by this pest is shown by a statement of Mr. Pratt, who reports that within a certain area of fifty acres 70 per cent. of the trees had been attacked by *T. gestroi*. In another case, from fifteen to twenty trees in the immediate vicinity of a nest had been destroyed. The work of *T. gestroi* is most insidious, the trees being usually injured beyond recovery before there are any outward indications of the presence of the enemy. Queens of this species are very rare, or extremely difficult to find. The main centre of the colony is usually at a considerable distance from the point of attack, but Pratt has shown that it may be discovered by following up the galleries of the insect, which almost invariably lead to a nest in some decayed log or buried stump. Should the gallery become obliterated in the course of excavation, its direction may be picked up by cutting a trench at right angles to the line. The termites will then construct covered ways connecting the severed ends of the passages. When the headquarters are discovered the nest should be destroyed by fire. The employment of a fumigator is strongly recommended.

This machine pumps the fumes of arsenic and sulphur into the galleries of the termites. A source of infection having been located in some decaying log, a deep trench is dug round the spot. This will expose the efferent galleries, which are said to be of a lenticular section of over 1 in. in diameter and ¼ in. high. They usually run from 1 to 2 ft. below the surface of the ground. The infested log is first dealt with. If it is impracticable to burn it, a hole should be bored into the hollow portion of the wood and the deadly fumes pumped into it. Exits from which smoke emerges should be blocked with clay. Should the log be a large one, a series of holes must be successively bored and fumigated, care being taken to plug up the previous hole before making a fresh one. Attention must next be given to the efferent galleries disclosed on the outer walls of the trench, and the fumes injected into these one by one. Wherever the smoke is seen to escape—which may be many yards away from the point of injection—such exits must be stopped with earth or clay. Living rubber trees that have been partially hollowed out by the insects may be treated in the same way. Where, from the nature of the soil, it is impossible to trace the galleries, deep hoeing of the infested area has been recommended. Infected areas may be isolated by surrounding them with a 4 ft. trench. It would appear that the insects are dependent upon dead wood for their continued existence. In the absence of such material they may subsist for a time in the living trees, but will not thrive under such conditions, and will eventually die out. It is consequently most important to rid the plantation of fallen timber and decaying stumps of trees. This may not be practicable in heavily timbered new clearings, but should be the object at which to aim. The early destruction of all logs found to contain the termites is essential.

In Brazil, *Coptotermes marabitanos* is said to attack the areas of wood exposed by tapping the rubber trees.

*Neuroptera.*

This Order can scarcely be said to be represented in our catalogue of rubber pests, but I have a record of a species of *Psocus* which was found to be swarming on some sheet rubber on its arrival in Colombo from the Federated Malay States. The rubber had evidently been packed before it was quite dry, with the result that the surface was covered with mould, upon which the small insects were feeding. They were not doing any actual injury, but their presence in such large numbers would probably affect the market value of the rubber.

### *Hymenoptera.*

The ends of stumped plants are very frequently tunnelled by various small bees and wasps, which habitually choose such situations for the construction of their nests. Various species of *Ceratina* fill these tunnels with cells containing a mixture of pollen and honey. But the wasps store their cells with paralysed insects destined for the nourishment of their young. *Trypoxylon intrudens* provides small spiders, and *Stigmus niger* employs Aphides for the purpose.

When a plant is stumped the cut end usually dies back to the next node, from which the new shoots will be produced. It is the dead pith in this dry portion that attracts the insects. They will not burrow into living sappy stems, nor will they enter by any but a cut or broken surface. It is possible that the excavation in the dead part may lead to an extension of the decay; but this has not been proved. Any possible danger from this cause may be obviated by stumping the plant immediately above the node, leaving, say, half an inch to prevent chance of injury to the axillary buds. There would then be little or no dead wood to attract the insects. Where this precaution has not been taken, the terminal dead parts should be cut or broken off as soon as they are thoroughly dry.

The deserted tunnels of these wasps and bees are sometimes tenanted by a species of *Thrips*, which has consequently been regarded with suspicion. But this particular species is quite harmless, and may indeed be a friend rather than an enemy. It is an insinuating little creature, and penetrates into the galleries of the "shot-hole-borer" of the tea plant, where it is believed to attack the young larvæ of the beetle.

*Coleoptera.*

This Order of insects, containing as it does the whole tribe of beetles, provides the largest number of names on our list.

The grubs of various Melolonthidæ (Cockchafers) attack the roots of young Hevea plants. Of these, the larvæ of *Lepidiota pinguis* is the most troublesome in Ceylon, and is sometimes responsible for a large number of vacancies in a new clearing. It is a large white grub, measuring about 3 in. in length. The beetle, which attains a large size, flies at dusk, and lays its eggs just below the surface of the ground. The newly hatched larvæ burrow down into the soil and attack the roots of the neighbouring plants. The insect by no means confines its attention to Hevea plants. It is probably more or less omnivorous. It was at one time a notorious coffee pest, and is now a serious enemy of cinnamon in the low-country of Ceylon. Its appearance in large numbers in rubber clearings is probably due to the facility with which the beetle is enabled to deposit its eggs in the newly turned soil immediately surrounding the young plants. The clean weeding of clearings also tends to concentrate the grubs at the roots of the rubber plants. If there is an insufficiency of food at one spot, the grubs will come up to the surface and wander to adjoining plants. The tap root of the rubber plant is often eaten clean off to within an inch of the surface of the soil. One of my correspondents informed me that he had lost 3,000 plants in a single clearing, and had extracted five or six of the grubs from each hole. I have received no reports of damage to older trees.

Nitrate of soda has a well-marked effect in ridding the soil of insects, besides being a useful fertilizer. It may be applied at the rate of 1 to 2 oz. for each plant. A correspondent to whom I recommended this treatment reported that the grubs quickly deserted the holes treated with this substance. "Vaporite," a patent insecticide, has a similar result, but must not be allowed to come into direct contact with the tender roots.

A small Rutelid beetle (*Cingala tenella*) perforates the foliage of young plants, but does no serious damage.

A species of *Oryctes* is accused of attacking the foliage of Hevea in Penang. Of an allied beetle (*Xylotrupes* sp.) Mr. Pratt, referring to Hevea pests in the Federated Malay States, writes as follows: "This beetle has caused more damage to young plantations than any other insect pest. Its habits are peculiar. As soon as any young shoots appear on newly planted stumps these are bitten off, and such repeated attacks eventually render the stump quite valueless. A 'supply' suffers the same fate. So extensive is the damage so caused that I have seen 300 acres eighteen months old without a green leaf. On another occasion 1,000 acres suffered in the same way. The original difficulty was to find the cause of the trouble, as the attacks were much like those of *Brachytrypes achatinus*. It was eventually found through shooting a crow within the crop of which portions of the beetle were found, while attached to these pieces were scraps of coagulated latex. This led to the discovery of the culprit. It is curious that over the affected areas not a single beetle was to be found during the daytime, and long searches all through the night led to no result. The beetles were afterwards found resting during the day in older rubber surrounding the newly planted area, or in jungle. The attacks are easily prevented by means of a cylinder made of ordinary newspaper the size of a full sheet. These cylinders are about 6 in. in diameter, the height of a newspaper, and are fastened by three pins. The cylinders are placed over the stumps, thus forming a guard, and by means of three thin stakes on the inside they are fixed in position." The symptoms of attack must be very similar to those caused by the "rubber slug" (*Mariælla*) in Ceylon, where the author of the injury similarly defied detection for a considerable time.

A large Elaterid beetle (*Alaus speciosus*) is frequently found resting upon Hevea stems, and has been regarded with suspicion. It is probably merely a casual visitor. Living specimens imprisoned with sections of rubber stems made no attempt to feed upon the bark. It must be remembered, however, that the larvæ of many Elaterids, under the popular name of "wire-worms," are recognized as agricultural pests of some importance.

In the Cerambycidæ—or Longicorns—we have at least one serious pest. This is the large and handsome *Batocera rubra*, the larva of which tunnels into the tap root and stems of well-grown Hevea trees. The insect is indigenous in Ceylon, but has only recently attracted attention as a rubber pest. Isolated cases of injury by some large borer have been reported at intervals for the last seven or eight years, but all attempts to determine the adult insect proved unsuccessful until 1912, when the species was finally identified. The injury may take two forms, either central or peripheral. In the former case the centre of the tap root is hollowed out, and the tunnel may extend well up into the base of the stem, increasing in diameter as the grub grows larger. In the second case the attack is from the outside, usually at or just below ground level. Occasionally the point of entry may occur higher up on the stem. Irregular cavities are eaten through the bark and into the wood of the tree. Sometimes the injury is confined to the outer parts; at other times a tunnel is driven right into the heart of the tree. It is possible that these two forms of injury may be due to the work of two distinct species of beetles, but I have been unable to detect any difference in the larvæ. The symptoms of attack are usually obscure. There may be a gradual loss of foliage, but this is not readily distinguishable from the natural periodic defoliation. When the injury is below ground level, the first intimation may be the collapse of the tree, which frequently breaks off at a point a few inches below the collar. Or, in sheltered situations, the tree may gradually die and dry up. When the stem is attacked from the outside, at or above the collar, the wound may be discovered by an oozing of diseased sap. There is no very noticeable extrusion of excreta, much of this matter being retained in the tunnel. The method of entry, in cases of external attack, is a comparatively simple matter. The eggs are deposited in deep cavities of the bark and in wounds, especially such as have been induced by canker. Where entry has been effected in the tap root at some distance below ground the procedure is more obscure. These beetles are not in the habit of burrowing into the soil. A probable explanation is that the egg in such cases has been deposited at the collar of the tree, and that the young larva, failing to penetrate the healthy bark, works its way downwards until it reaches some point where a decayed or broken lateral root affords it an opportunity of penetrating to the wood without running the gauntlet of the laticiferous cells. Although, when once it has effected its entry, the grub is capable of causing fatal injury to the tree, I have so constantly found indications of canker and other fungal diseases associated with the presence of the borer that I am inclined to believe that its normal mode of entry is through a diseased area of the bark. Fortunately, instances of damage by this borer are comparatively few. But in consideration of the fact that a single grub may be responsible for the death of a fine rubber tree, and that an individual beetle may infect many such trees, it will be prudent to give the matter some attention before it becomes really serious. Remedial measures must take the form of the collection of the adult insects. The destruction of each individual beetle of this species may possibly save the lives of a dozen rubber trees. It is unlikely that they occur in any considerable numbers, and it would be useless to employ coolies solely to collect the insects. But a small reward might be offered for each beetle of this kind that may be brought in by the tappers or scrap collectors. If, as I believe, the eggs are deposited in wounds and cankered patches of bark, it will be important to safeguard these possible points of entry by cutting out all diseased areas and tarring the exposed surfaces. The same treatment should be applied to accidental wounds. Tapping wounds, especially those made by the paring system, are so constantly disturbed that there is little chance of the pest being able to establish itself in those spots.

An undetermined Cerambycid larva has been found in stems of Hevea in Java.

Another Longicorn that has acquired an evil repute is

*Mœchotypa verrucicollis.* This beetle has the reputation of damaging the stems of young Hevea trees by gnawing off the bark. A number of the living beetles were submitted to me, together with an example of their work. The injured stems showed irregular patches of the (still green) bark destroyed, in some cases completely ringing the tree. It was noticeable, however, that no latex had exuded from the wounds, and examination of the roots disclosed the presence of a fungus (*Botryodiplodia elastica*). The probability, therefore, was that the injured plants were diseased and had ceased to produce latex before the advent of the beetles. To put the matter to the test, I confined some of the beetles in a cage, together with a healthy young Hevea tree. I watched one individual climb up the stem and fix its jaws in the tender bark. The first puncture resulted in a bead of latex which adhered to the mouth-parts of the beetle, and evidently proved very distasteful to it. The insect immediately abandoned the attack and moved off, doing its best to remove the sticky fluid. Other individuals made similar attempts to feed, but were promptly repelled in the same way, nor could they be induced to repeat the experiment. After a week's confinement without other food they still refused to touch the living bark; but when supplied with fresh branches of Cassia, they speedily stripped them. My successor, Mr. Rutherford, on the other hand, in a recently issued report, expresses himself as convinced by experiment that these beetles are able to consume healthy Hevea bark with impunity, but that they prefer withered bark.

A smaller beetle—*Niphona* sp. (near *parallela*)—has been accused of similar injury.

In the Federated Malay States two small Longicorns——*Epepeotus luscus* and *Clytanthus annularis*—have been included amongst rubber pests on somewhat slender evidence. The former is reported as having been "once found in the trunk of a Para tree," while the latter "once oviposited on Para seedlings." *Clytanthus annularis* is a well-known borer in bamboos, and it is improbable that a bamboo insect would attack such a totally different plant as Hevea.

Anthribiidæ figure in our list, on the strength of an undetermined species of this family found damaging Para wood in the Malay States.

The Curculionidæ (weevils) are all phytophagous, many of them being notorious as defoliators of various trees, while others are injurious in their larval stages as borers in the stems of plants. I have no records of Curculionid attack on rubber in Ceylon; but *Astycus chrysochloris* —a handsome golden-green weevil—and *Hypomeces squamosus*—a dull black species—are credited with injury to Hevea in Malaya. The same Hypomeces, in company with *Derodes curtus* and a species of *Phytoscapha*, is accused of similar habits in Java; while in the Belgian Congo these species are replaced by *Ischnotrachelus humeralis*, *Blosyrus seminitidus*, and species of *Isaniris* and *Piezotrachelus*. Should these leaf-eating beetles become really troublesome, spraying with Paris green or lead chromate would afford relief.

Bostrichidæ and Scolytidæ, though belonging to distinct families, may be conveniently discussed together, as they are of very similar habits and appearance, and are lumped together under the popular term "shot-hole borers." The following species have been recorded as associated with Hevea:—

*Xylopertha mutilata:* Boring in dead stems. (Ceylon, F.M.S.)

*Xyleborus affinis*. (Cameroons, Hawaii, Java.)
,, *ambasius*. (Cameroons.)
,, *camerunus*. (Cameroons.)
,, *cognatus*, in seedlings. (Ceylon, Tonkin, Cameroons.)
,, *confusus*. (Cameroons.)
,, *discolor*, in stems of young plants and in dead leaf-stalks. (Ceylon.)
,, *interjectus*, under blisters of renewed bark. (Ceylon.)
,, *morigerus*. (Ceylon.)
,, *obliquicauda*. (Ceylon.)
,, *parvulus*. (F.M.S.)
,, *perforans*, in dead and diseased stems. (Ceylon.)

*Xyleborus semigranosus.* (Ceylon.)
,, *semiopacus,* boring in dead stems. (Ceylon, F.M.S.)
,, *submarginatus.* (Ceylon.)
*Cryphalus plumieriæ,* in dead stems. (Ceylon.)
,, *congonus.* (Belgian Congo.)
,, *heveæ.* (Belgian Congo.)
,, *tuberculosus.* (Belgian Congo.)
*Platypus solidus,* in diseased stems. (Ceylon.)
*Eccoptopterus sexspinosus,* in dead and diseased branches. (Ceylon.)
*Phlœotribus puncticollis.* (South America.)
*Coccotrypes* sp., in dead leaf-stalks. (Ceylon.)

It is not surprising that the list is a long one, and it could probably be greatly extended. It should be understood, however, that, though all these boring beetles were found in Hevea stems, it does not follow that they are equally concerned in injury to the tree. In many cases the trees had been dead for some considerable time. In the tropics, such dead trees are rapidly infested by boring insects of various kinds. It is, indeed, doubtful if any of these small beetles can penetrate the healthy bark of a rubber tree without being hopelessly involved in the viscid latex. I have frequently found dead beetles embalmed in a clot of coagulated latex—victims of rash experiment. But should anything cause a permanent or temporary cessation of the production of latex, such insects immediately seize their opportunity. Both Bostrichidæ and Scolytidæ are strongly attracted by bark or wood that has been infected by canker and other fungoid diseases. Hevea trees are subject to several serious fungoid diseases, including a canker very similar to that of the cocoa. In no instance have I found borers in sound, healthy bark. A healthy rubber tree is self-protected from boring insects by its own laticiferous secretions. In the incipient stages of canker only the superficial layers of bark are involved. Borers will attack these spots and will attempt to gain an entrance; but, as soon as they reach the deeper and, as yet, unaffected layers, they are repelled by a flow of latex. In later stages of the disease, when the whole thickness of the bark is involved, latex is absent from the diseased tissues, and there is no hindrance to the progress of the insect, which can then perforate the bark with impunity, and even extend its galleries into the wood itself.

It sometimes happens that latex is found to be exuding from the perforations and flowing down the stem. This is accepted, by some planters, as proof positive that the beetle has attacked healthy laticiferous bark. But the phenomenon is explicable in other ways. In the early stage of the disease, when only the superficial layers of bark are affected, latex may exude from the deeper tissues through the abandoned galleries of insects that had attempted to push their work beyond the danger zone. Another cause of "bleeding" may result from the separation of dead bark from the wood, leaving a cavity which often becomes filled with latex from surrounding healthy tissues. If the dead bark is imperforate, the latex coagulates and forms a pad; but if it has been pierced by borers the latex will find its way to the surface. It is possible even that borers might attack otherwise healthy bark during a temporary cessation of activity in the laticiferous vessels resulting from excessive drought or over-tapping. Should this happen a shower of rain might induce renewed activity, and bleeding through the perforations would then occur. The exudation of latex and the presence of boring beetles may be regarded as a valuable indication of incipient disease, thus allowing of early treatment before the disease has become deep-seated. Similar conditions have been observed in other countries. Dr. Aulmann, in "Die Fauna der Deutschen Kolonien," speaking of *Xyleborus affinis* in the Cameroons, remarks that only trees depleted of sap by tapping are attacked, as the beetles are killed by the flow issuing through the bore-holes made on full-sapped trees; and adds that careless tapping exposes the wood and favours attack.

### *Lepidoptera.*

No very serious caterpillar pests of Hevea have been recorded, though several species are known to feed occasionally on the foliage of the plant. Amongst these may be mentioned the large Saturniids: *Attacus atlas* and *Antheræa paphia;* a Limacodid, *Thosea* sp.; a Lymantrid, *Orgyia postica;* a Psychid, *Clania variegata;* a Noctuid, *Agrotis segetis*, which cuts through the stems of young seedlings; and the Tineid *Comœritis pieria*, the caterpillars of which feed on the outer bark of living rubber trees, but seldom penetrate deep enough to cause any flow of latex. A small Cossid, *Arbela quadrinotata*, has a similar habit, but works on a larger scale. This caterpillar, moreover, tunnels into the wood, at the angles of the branches, to form a retreat for itself during the daytime. It feeds at night only.

Mr. G. E. Bodkin, in his "Report of the Economic Biologist, 1912-13," records a somewhat severe attack upon Hevea in British Guiana by the caterpillars of a hawk-moth, *Dilophonota ello*, which was, however, reduced by the appearance of a small egg parasite (*Telenomus dilophonotæ*).

Should artificial remedies be necessary, in the case of a plague of caterpillars, arsenical sprays are always available.

### *Diptera.*

This Order is represented only by the larvæ of an undetermined Phorid, which were observed in Ceylon feeding on decomposing smoke-cured rubber.

### *Hemiptera.*

Two bugs, a Pyrrhocorid, *Leptocorisa acuta*, and a Capsid, *Calicratides rama*, have been credited with puncturing young Hevea plants in Ceylon, thereby causing the terminal shoots to wilt and droop; but injury from this cause is rare. A Pentatomid, *Empicoris variolosus*, is said to cause exudation of latex from young Hevea shoots in British Guiana.

The following Coccidæ have been noted as occurring upon Hevea:—

*Aspidiotus destructor*, on foliage. (British Guiana.)
,, *transparens*, on foliage. (Java.)
,, *ficus*, on foliage. (Java.)
,, *personatus*, on foliage. (British Guiana.)

*Mytilaspis rubro-vittatus*, on foliage. (Ceylon.)
*Parlatoria proteus*, on foliage. (Java.)
*Chionaspis dilatata*, on foliage. (Java.)
*Lecanium nigrum*, on young stems and foliage. (Ceylon, Java, Seychelles, British Guiana, Hawaii.)
*Vinsonia stellifera*, on foliage. (British Guiana.)
*Asterolecanium pustulans*, on stems. (British Guiana.)
,, *pustulans seychellarum*, on stems. (Seychelles.)
*Pseudococcus virgatus*, on foliage. (Hawaii.)

All Coccidæ are potential pests. Any species, though at first of only casual occurrence, may suddenly increase beyond the normal and become formidable. But of those known to occur upon Hevea, *Asterolecanium pustulans* and *Lecanium nigrum* are the only species of any present importance. The former is responsible for an unhealthy condition of the stem. The insects occupy small depressions on the bark. When they occur in considerable numbers the bark assumes an unhealthy hidebound and nodular condition that must greatly interfere with the processes of tapping, and may even check the elaboration of latex. *Lecanium nigrum* sometimes encrusts the young stems and branches to an extent that seriously checks the growth of the plant. Mr. Dupont informs me that, in Seychelles, this species is held in partial check by a parasitic fungus (*Hypocrella* sp.), which attacks it wherever it occurs.

With such a large area of plantation rubber now in cultivation it may be considered astonishing that the catalogue of pests is so small. The increased attention that is now being given to the diseases of plants renders it more difficult for any pest to gain a foothold. It is quickly observed, and measures are taken to check it before it has had time to establish itself firmly.

It should be remembered, however, that large unbroken areas of a single cultivation must always afford the best opportunity for the increase and spread of any pest, and will render attempts at remedial treatment the more difficult. It is sound policy to break up such areas by interposing belts of other trees, which will tend to confine any enemy within practicable limits.

Catalogue of animal pests associated with the Hevea rubber tree:—

MAMMALIA:—

Domestic cattle.
,, goats.
Elephants.
Deer (various).
Antelope.
Wild pig.
Monkeys (various).
Porcupine.
Bandicoot.
Jungle rat.
Mice.
Hares.

MOLLUSCA:—

*Mariælla Dussumieri.*
*Veronicella virgata.*
*Parmarion* sp.

INSECTA:—

Orthoptera.
Gryllidæ.
*Brachytrypes achatinus.*
*Gymnogryllus elegans.*
*Cyrtacanthacris* sp.
Acridiidæ.
*Aularches militaris.*
*Tropidacris cristata.*
*Zonocerus elegans.*
,, *variegatus.*
Locustidæ.
*Cleandrus* sp.
Termitidæ.
*Termes redemanni.*
,, *obscuriceps.*
,, *Horni.*
,, *gestroi.*
*Eutermes inanis.*
*Coptotermes marabitanos.*

INSECTA (*continued*).

Neuroptera.

*Psocus* sp.

Hymenoptera.

*Trypoxylon intrudens.*

*Stigmus niger.*

*Ceratina* spp.

Coleoptera.

Lamellicornia.

*Lepidiota pinguis.*

*Cingala tenella.*

*Oryctes* sp.

*Xylotrupes* sp.

Longicornia.

*Batocera rubra.*

*Mœchotypa verrucicollis.*

*Niphona* sp.

*Epepeotus luscus.*

*Clytanthus annularis.*

Elateridæ.

*Alaus speciosus.*

Anthribiidæ.

*Anthribia* sp.

Curculionidæ.

*Astycus chrysochloris.*

*Hypomeces squamosus.*

*Dereodes curtus.*

*Phytoscapha* sp.

*Ischnotrachelus humeralis.*

*Blosyrus seminitidus.*

*Isaniris* sp.

*Piezotrachelus* sp.

Bostrichidæ.

*Xylopertha mutilata.*

Scolytidæ.

*Xyleborus semiopacus.*

,, *interjectus.*

,, *perforans.*

,, *discolor.*

,, *obliquicauda.*

,, *semigranosus.*

INSECTA (*continued*).

Coleoptera (*continued*).

Scolytidæ (*continued*).

*Xyleborus submarginatus.*
,, *morigerus.*
,, *affinis.*
,, *cognatus.*
,, *confusus.*
,, *ambasius.*
,, *camerunus.*
,, *parvulus.*
*Platypus solidus.*
*Eccoptopterus sexspinosus.*
*Phlœotribus puncticollis.*
*Coccotrypes* sp.
*Cryphalus plumieriæ.*
,, *congonus.*
,, *heveaæ.*
,, *tuberculosus.*

Lepidoptera.

*Attacus atlas.*
*Antheræa paphia.*
*Dilophonota ello.*
*Thosea* sp.
*Arbela quadrinotata.*
*Orgyia postica.*
*Clania variegata.*
*Agrotis segetis.*
*Comœritis pieria.*

Diptera.

*Phora* sp.

Hemiptera.

Pentatomidæ.

*Empicoris variolosus.*

Pyrrhocoridæ.

*Leptocorisa acuta.*

Capsidæ.

*Calicratides rama.*

INSECTA (*continued*).

Hemiptera (*continued*).

Coccidæ.

*Aspidiotus destructor.*
,, *transparens.*
,, *ficus.*
,, *personatus.*
*Mytilaspis rubro-vittatus.*
*Parlatoria proteus.*
*Chionaspis dilatata.*
*Lecanium nigrum.*
*Vinsonia stellifera.*
*Asterolecanium pustulans.*
,, ,, *seychellarum.*
*Pseudococcus virgatus.*

## TERMES GESTROI AS A PEST OF THE PARA RUBBER TREE.

By H. C. PRATT.

*Government Entomologist, Federated Malay States.*

THE plantation rubber industry which developed with phenomenal rapidity in the Malay Peninsula has not been threatened with any serious insect pests. Before any considerable acreage had been planted it was generally considered that *Termes gestroi* would prove a menace to the industry, and it was decided to offer the sum of £5,000 for an adequate remedy against its attacks upon the Para rubber tree. This reward induced competitors to forward for testing purposes a large number of so-called remedies.

There is no doubt that at that time there was a good deal of justification for the alarm caused by this insect. Many plantations, especially those on the low-lying lands, were losing a very considerable number of trees apparently through the attacks of *T. gestroi*. The ordinary "Sumatras"[1] which from time to time pass over this country blew down a large number of trees which lay directly in their tracks. One estate lost on one occasion approximately 2,000 trees of 4 and 6 years of age in the course of fifteen minutes, the majority of which were found to have been hollowed by *T. gestroi*. Factors such as these led to the offering of a reward for a practical remedy, and they were also responsible for the nervous apprehension of the future of the industry which was prevalent at the time among most planters.

In view of this a short account of the causes which led to the increase of the insect and its attack upon the Para rubber tree will be interesting.

It was apparent at the time that on lalang[2] land, or

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[1] A strong wind, often very local, and of short duration.

[2] A tall grass, which grows very thickly.

land which had been cleared of virgin forest for a number of years and was then planted with Para rubber, very few trees were lost. It was equally apparent that fewer trees were lost on the undulating country than on the low-lying flat country which is prevalent on the Malayan coast. The reason was pointed out by Ridley several years ago, viz., that in his opinion *T. gestroi* would not attack a sound and healthy tree, and he attributed the cause to root disease, although advancing no definite proof. Experience has shown this assumption to be well founded, although it did not meet with general approval at the time, and is often refuted now. Trees which are attacked by *T. gestroi* often show no signs of fungus attack, as the mycelia are quickly devoured by the insect, and the wood affected by the fungus is the first point of attack. As very few trees show signs of the presence of the pest until thoroughly hollowed out, indications of a fungus attack are thus usually destroyed. That the original trouble is due in nearly every instance to fungus or to bad drainage causing root-rot may be taken as an established fact.

That the flat lands suffered more than hilly country was only to be expected. The jungle on the flats is usually heavier and the burns less satisfactory, resulting in a network of scorched timber lying over the surface of the soil. The damp soil in such situations and the draining difficulties offer additional facilities for the spread of root diseases and the increase of *T. gestroi*. In such situations there is often a surface layer of peat, which forms a connected network of fibrous matter and small decayed roots. Such a combination of favourable factors for the increase of root disease and *T. gestroi* is absent on the hilly lands.

At the commencement of the industry it was the object of those concerned to plant as great an acreage as possible in the shortest space of time. No attention was paid to the rotting timber, and such conditions were admirably suited for the rapid multiplication of the insect. It quickly took advantage of the facilities thus offered, and increased at an immense rate for several years. At the time it was pointed out that a gradual diminution in its numbers was to be expected as soon as most of the timber on the land had rotted. *T. gestroi* as a pest of the Para rubber tree is dying a natural death, and its rise and fall is directly attributable to the exceptional facilities offered when immense tracts of jungle were felled.

Many hundreds of nests of *T. gestroi*, both in rubber trees and in dead wood, have been examined carefully for queens, and there can be no doubt that the queen is extremely rare. The majority of nests are without queens, although both young and eggs may be present. Haviland's opinion that the eggs are carried from nest to nest seems the only feasible explanation of their presence in so many nests without their being any indication of a queen. The general construction of the nest is always the same, but its extent varies considerably. No mounds are ever made. As a rule the nest is formed inside dead stumps, buried trees, or within fallen trees on the surface of the ground. The main nests, of which there may be ten or more in a single colony, are formed of thin laminæ of comminuted woody matter, and are as fragile as the honeycombs formed by those species which cultivate fungi. The nests are entire, but from them proceed burrows which often connect with other nests situated considerable distances away. On the coast lands some of these runs have been traced for 600 ft. in one direction, the separate nests of the colony being anything from 25 to 200 ft. apart. These extensive underground runs which link together the various nests are flat and fairly broad, forming a passage into which a microscope slide could be inserted. Within them workers and soldiers are usually present, although a nest may be 100 ft. away. Such extensive nests are met with only on flat lands, but it is curious that even with such large nests no queens were found. Should root diseases be at all prevalent on an estate where there are large connected underground colonies of *T. gestroi*, it is to be expected that many trees will be attacked by this insect. On the other hand, it is remarkable that this species is the only termite found eating the living portions of a rubber tree, although *T. travians* possesses many habits in common with it, and is frequently found on rubber estates.

During the rainy season *T. gestroi* will frequently encase the trunk of a rubber tree with mud, and when this happens it provides the only definite proof that a tree is affected by this pest. Such trees are usually marked in some conspicuous way, *e.g.*, by tying a red piece of cloth round them, and are subsequently treated.

More remedies have been tried in connection with this insect's attacks upon rubber than in the case of any other pest in the Malay States. It may safely be concluded from present experience that the only efficient remedy is to apply the fumes of arsenic and sulphur by means of the "Universal White Ant Exterminator," which has been used extensively in South Africa and Ceylon, although not for *T. gestroi*, and is extensively used in the Federated Malay States. This machine was imported here in 1908, when several trees in the experimental gardens were treated for termite attack. There has been no recurrence of attack on any of these trees since that time, now six years ago. The fumes, which are pumped either into the tree or into the runs, are formed by arsenic and sulphur placed on red-hot charcoal. The charcoal is placed within the cylinder made for the purpose, the fumes being forced through a flexible tubing, fitted with a nozzle, by means of an attached pump, which also keeps the charcoal red hot. The proportion of arsenic and sulphur is, I believe, 80 and 20 per cent. respectively. This machine is of especial value, and very easy to work in destroying those colonies of termites which form mounds.

Quite a fair proportion of young trees which are treated in this way for *T. gestroi* die within a few weeks, although there may be no return of this pest. Such cases I attribute to the presence of fungus previous to termite attack. In quite a number of instances there is evidence for the assumption that the insect not only checks the growth of root fungi, but actually destroys all traces of it, and such trees when treated for termite attack will recover, and continue to give good yields for many years.

## THE PRINCIPLES OF HEVEA TAPPING, AS DETERMINED BY EXPERIMENT.

By T. Petch, B.A., B.Sc.

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It is now thirty-two years since the first Hevea tree was tapped in the Eastern tropics. The Brazilian methods, described by Cross, were adopted, and for the next fifteen years those methods—what would now be termed "incision" methods—held the field. A great advance was made when Ridley described the now typical Eastern method of reopening the cut, a method which more than anything else made plantation rubber a commercial possibility. But in the early days of this "excision" method the cuts were not reopened for more than about fourteen tappings; that is, only until about 1 in. of bark had been removed. The method now in vogue of gradually removing the whole of the cortex to a height of 3 or 6 ft. dates from about 1904. This sequence is worthy of remembrance, since it explains many of the recommendations of the pioneer advocates of rubber planting which to-day appear so obviously wrong; they never contemplated such treatment as the tree now undergoes.

Early tappings, even in botanic gardens and experiment stations, were merely "tappings for yield," *i.e.*, it was simply desired to ascertain whether the trees would yield rubber, and, if so, how much. It is rather to be feared that this phase, necessary twenty years ago, has persisted to the present day, though scarcely any country can now remain in which such tapping can be justified as work for an experiment station. According to current ideas, tapping experiments should be carried out as far as possible on virgin trees, and it is a waste of material to sacrifice such trees without endeavouring to obtain further evidence on some definite problem. And the experimenter should not permit himself to be deterred by the criticism that his tapping problem is "purely academic." Our knowledge of rubber tapping would have been in a far more advanced stage to-day had experiment stations and botanic gardens restricted their tapping experiments to "purely academic" problems during the last ten years.

The first attempt to ascertain the fundamental principles of Hevea tapping was made by Parkin in Ceylon in 1898. He dealt with single incision methods only, *i.e.*, either single oblique cuts, or single small V's arranged more or less regularly over the lowest 6 ft. of the stem. He was followed by Arden, who carried out further experiments in the Federated Malay States in 1901-02. Arden also worked chiefly with single incision methods, but in some experiments he adopted the "excision" method, limiting the reopenings of the cut, however, to fourteen.

The ideas obtained from Parkin's and Arden's experiments have practically governed Hevea tapping until quite recently, though it is clear that they were founded on quite a different style of tapping from that in vogue. Dr. A. W. K. de Jong has recently carried out more exact experiments in Java on some of the questions dealt with by Parkin and Arden, as well as on other points, by modern methods of tapping, and his *Bulletin* (*Hevea brasiliensis, Wetenschappelijke Proeven, Buitenzorg,* 1913) now supplies a scientific foundation. His experiments were carried on, as a rule, for a period of eight months. Herein lies a possible source of error in some cases, for, at the risk of seeming unduly critical, one must at present insist that comparative tapping experiments should, with few exceptions, be carried on until the available tapping area has been completely tapped.

Among the points established by Dr. de Jong are the following:—

(1) As a rule a cut of a given length and direction gives the same yield, if made at the same height on the tree, on whatever side it may be placed.

(2) Two equal cuts yield more than a single cut equal to their combined length, the slope and height from the ground being the same.

(3) Cuts to the left yield more than equal and equally

inclined cuts to the right at the same height, whether on the same or opposite sides of the tree.

(4) A yield from a V cut is greater than that from a single cut to the right whose length is equal to the combined length of the two arms of the V, but less than the yield of a similar single cut to the left.

The first two results, though some exceptions were met with, establish the general rule that it is immaterial on which side of the tree a tapping experiment is instituted. The third and fourth are of great importance in actual estate tapping. It may be explained that the phrase "tapping to the left" has been adopted to denote the half herring-bone system with the cuts to the left of the vertical channel.

We may now proceed with the special object of this paper, which is to discuss the results arrived at in various tapping experiments and the practices generally adopted, from more or less accurate results, on estates. It will be convenient to consider them under the different factors which are now known to influence such results.

*The Area of the Tapping Surface.*

By tapping surface is meant the part of the tree which is being tapped on any one occasion. Area of tapping surface is usually stated, as far as its breadth is concerned, in terms of the circumference. The tree may be tapped all round, or on a vertical strip whose breadth is one-half, or one-third, or one-quarter of the circumference.

Tapping all round the tree at the same time has been abandoned, though an approach to it still exists in some "change over" systems. Excision systems which tapped all round the tree were the full spiral, and the full or half herring-bone on both halves of the tree, tapped on the same day. An experiment carried out on young trees at Peradeniya showed that, in alternate day tapping for a year, the full spiral, tapping all round the tree, yielded less than either the full or the half herring-bone on half the tree. The experiment is not free from objection, but the difference was so great that it is probably correct.

Opinions are now divided between tapping on one-half, one-third, or one-quarter of the circumference. As a variant of the half, tapping opposite quarters at the same time is practised. In some Peradeniya experiments, which again are open to objection, tapping on one-third gave almost the same as tapping on opposite quarters for a year, though the yield in the latter case fell off more rapidly towards the end of the period than in the former.

There is, unfortunately, no straight experiment which compares tapping on opposite quarters with tapping on half the circumference. As a rule the difference in the area has been combined with a difference in the method or pattern of tapping, such as a full herring-bone on half the circumference versus half herring-bone on opposite quarters.

Tapping on one-third the circumference has been adopted in some cases, but it has the disadvantage that it is difficult to change subsequently to quarters on the same area.

The view is now generally accepted that this question must be decided from the point of view of the welfare of the tree rather than that of yield. Fitting's results have been fully appreciated by the planting community, though it has been overlooked that tapping all round the tree was condemned on physiological grounds by Parkin in 1899, even for single incision tapping.

*The Direction of the Tapping Cut.*

In 1906 Mr. C. O. Macadam, of Culloden Estate, found that tapping to the left yielded more rubber than tapping to the right of the vertical channel. No reason was discovered for this until 1909, when it was found that in Hevea the vessels and latex tubes, in general, sloped up to the right, and consequently a cut to the left severed more latex tubes than an equal and equally sloped cut to the right. This has been completely confirmed by Dr. de Jong, who finds that the difference in yield is almost exactly accounted for by the difference in the number of latex tubes severed.

On this finding, a half herring-bone to the left yields more than a half herring-bone to the right, while the yield of the full herring-bone, on the same area, should be intermediate between the two. In searching for confirmation of this in the published experiments, one finds that in the majority of cases the direction of the cuts of the half herring-bone has not been recorded, and hence no valid conclusions can be drawn. A more serious defect is that, in general, experiments on the problem of half *versus* full herring-bone have been combined with experiments on half *versus* quarter circumference. So far as I am aware there is as yet no definite comparative experiment, except that of Dr. de Jong, between the half and the full herring-bone, or their reduced equivalents, the single and the V cut. In an experiment carried out at Peradeniya for twelve months in 1910, on half the circumference in each case, the half herring-bone to the left yielded more than the half herring-bone to the right, but the full herring-bone yielded more than either. As, however, the number of cuts was varied during the year this result is inconclusive.

An experiment on this point is decidedly wanted: I mean an experiment carried on until all the available tapping surface has been completed. The three patterns of tappings should be compared on quarters, and also on the half circumference. It would seem probable that the method which is most suitable for the quarter might not be most suitable for the half circumference.

In this connection it may be as well to call attention to another factor which vitiates so many of the earlier experiments. It is essential that all tapping in a comparative experiment should be done at the same angle. Not only does the yield per tapping vary with the angle, but the number of tappings which it is possible to make to the inch, measured along the channel, varies with the angle also. Now, the yield from a given area of bark depends to a great extent upon the number of tappings it is possible to make on that area, and the number of tappings depends upon the angle. The greater the angle the cut makes with the vertical the greater the number of tappings to the inch. Therefore, for two reasons, the yield from a given area depends upon the angle of the cut.

*The Distance between the Cuts.*

The cuts of the herring-bone have usually been made 1 ft. apart, without any special reason. Probably the most generally accepted idea in the earlier days of tapping was that the cuts should be placed so far apart that the bark between them was excised completely in one year. Experiments with different distances are entirely wanting, but they are not now required. In a Peradeniya experiment, which has been in progress for eighteen months, one set of trees is tapped with four cuts 1 ft. apart, another with two cuts 1 ft. apart, and a third with two cuts 2 ft. apart, in all cases alternate day tapping on one-third circumference; the two cuts 2 ft. apart have up to the present given the best yield. But from physiological investigations now in progress it would appear that prolonged continuous tapping on the same area is not to be recommended. In that respect the longer distance between the cuts is a disadvantage.

It may be noted that the tapping with two cuts 2 ft. apart, the lowest being 2 ft. from the base of the tree, yielded more than tapping with two cuts 1 ft. apart, the lowest in the latter case being only 1 ft. from the base. This conflicts with the prevalent idea that the lower the cut the greater the yield. That is true for a single tapping, but in prolonged tapping there would appear to be little difference in the yield whatever the height of the cut, provided it is within 3 ft. of the ground; 26 in. is now a common height for the lowest cut.

*The Number of Cuts.*

In 1905 it was customary to tap the lowest 6 ft. of the stem with a full or half herring-bone of six cuts 1 ft. apart. It was soon evident that the yields of these cuts were unequal, and that some of them occasionally "ran dry." But it was a long time before observation influenced practice. The only record on this point is one by Lock, who found that when the bark between the cuts was nearly exhausted the lowest cut yielded as much latex as all the other five put together. In six months' tapping the yield of the latex from the lowest cut was two and a half times that from the second, and four times that from the highest.

At the present day only one cut, or at most two, is used. Two cuts yield about 40 per cent. more than one cut. The ultimate advantage of the one or the two cuts remains to be proved. It is not decided whether the yield from, say, the lowest 3 ft. is less by tapping with two cuts than by tapping first with a single cut and, after the lower part of the tree has been finished all round, continuing with another single cut at 3 ft. The time required in the second case would be greater, while the difference in the yield is doubtful. But these are subjects for future experiments.

### *Tapping Intervals.*

Probably no other point has been the subject of so much discussion as the question of tapping intervals. A tapping interval is the time which elapses between successive tappings. That would appear clear enough, but the discussions show that it is not, and it is necessary to add that "a tapping" is the process of extraction of latex by cutting, whether it is performed on the same side of the tree as the last or on the opposite side. Each time the coolie cuts the tree is a tapping; if he taps one side of the tree on Monday and the other side on Tuesday, and so on, that is daily tapping on alternate sides.

In the second place, an experiment which sets out to show the difference in yield with different tapping intervals must be conducted on the same plan throughout. It is useless to alter the number of cuts as well as the tapping interval and then make deductions as to the effect of the latter. Most experiments on tapping intervals are vitiated by the introduction of other factors.

Given a straight experiment, *i.e.*, the same method of tapping, same number of cuts, same angle, and same fraction of circumference throughout, one clear result emerges, viz., that the longer the interval the greater the yield per tapping, up to an interval of about seven days. This, of course, refers only to tappings on the same side, not tappings on alternate sides. There are, as yet, no experiments on tapping one side continuously *versus* tapping two opposite sides alternately.

As already intimated, the yield per tapping in alternate day (two day) tapping is greater than the yield per tapping in daily tapping. But it is not twice as great. Hence the yield in a given time is greatest with the shorter interval. Alternate day tapping usually yields from 20 to 30 per cent. more per tapping than daily tapping. The yield at the end of a year in alternate day tapping is therefore not more than 65 per cent. of that obtained by daily tapping, but the amount of bark consumed is only about one-half. Alternate day tapping gives about 20 to 30 per cent. more rubber than daily tapping from the same area of bark, but it takes twice the time to do it.

Some doubt has been thrown on the above results by the experiments which have been in progress for six years on the old trees at Henaratgoda. In these experiments, in which the interval varies from one to seven days, the results at first were in accordance with the statements of the last paragraph. But after four years' continuous tapping the yield of the trees tapped at the longer intervals increased to such an extent that not only was the yield per tapping greater than with the shorter interval, but also the yield in a given time.

This result has been attributed to the fact that the trees are old and closely planted, and that consequently the trees tapped daily are overtapped. It will be necessary, therefore, to repeat the experiment with younger trees and a more conservative method of tapping. One such experiment is already in progress at Peradeniya.

It may be noted that tapping every three days has been practised in Ceylon, on at least one estate, for several years.

Many experiments give variants of interval experiments, or combinations of the interval factor with one other. Probably the most common is the experiment which combines daily versus alternate day tapping with the condition that the consumption of bark is to be the same in the two cases. This, of course, involves the use of twice as many cuts in the alternate day tapping.

Experiments by Tromp de Haas and others show that under such conditions the yield in alternate day tapping for a given period is less than that in daily tapping for the same period. Doubling the number of cuts does not compensate for halving the number of tappings.

Again, experiments by Spring and others show that doubling the area (horizontally) does not compensate for halving the number of tappings. Trees tapped on one-quarter daily yielded more than trees tapped in the same way on opposite quarters (together) on alternate days.

Thus, whether the amount of bark removed is equalized by doubling the number of cuts or by doubling the area operated upon, alternate day tapping yields less in a given time than daily tapping.

### *The Pricker.*

The use of the pricker has now been definitely abandoned on practically all estates in Ceylon. Experiments by Simon in Java have shown that, though the yield with the pricker is at first greater than that with the knife, it falls off more rapidly, and the yield at the end of six months or a year is less. This is fully confirmed by the results obtained at Peradeniya by using the old rotating pricker.

Experiments with the modern versions of this instrument lead to the same conclusion.

An experiment with the most recent Northway pricker at Peradeniya gave the following results: In two years the original bark had been completely tapped up to a height of 5 ft., the yield being 1,178 grammes per tree. In the parallel tappings on the same plot by four different excision methods, the consumption of bark in each case was only three-eighths of the above, while the yield varied from 1,690 to 2,180 grammes. These were for alternate day tapping. In daily tapping by the Northway system the original bark was completely tapped in seven and a half months, the yield being 670 grammes per tree; but the cuts did not heal properly, and it was then necessary to rest the trees.

*Future Experiments.*

Some indications of the type of experiment still needed have already been given, but one or two further remarks on this head may be advisable.

The experimenter should always adopt the most conservative system possible. Tapping experiments, to be of any value, must be carried on for several years, and it may happen that the system adopted will be out of date before they are concluded. An experiment was begun in 1908 in which the tapping system was a full herring-bone with three cuts on half the circumference. That was a conservative system then, when most estates were employing six cuts on half the circumference; but it has since been derided as exceptionally drastic.

During the last four years progress in tapping methods has been so rapid that most of the older experiments are of doubtful applicability to modern tapping. Experimenters nowadays must confine themselves to one or two cuts on not more than one-quarter of the circumference.

Perhaps the greatest scope for tapping experiments at present lies in the direction of what may be termed "change over" systems. It is recognized that in prolonged tapping on one area the yield gradually diminishes as tapping proceeds, though in estate work the diminution may be masked by the seasonal increase. It is also becoming evident, from investigations now being carried out by Mr. L. E. Campbell at Peradeniya, that the effect of tapping for a prolonged period on one side is bad from a physiological standpoint. These considerations favour the adoption of systems in which one side is tapped for two or three months, after which tapping is transferred to the other side. The general course is as follows: The first side is tapped for about two months. The second side is then opened, and both sides are tapped together for about a fortnight, until a full flow is established on the second side. Then tapping is stopped on the first side, but continued on the second for the next two months, after which it is changed to the first side again. Careful experiments dealing with the relative yields, percentage of rubber in the latex, and effect on the tree with such a tapping system as compared with the old method of tapping out one side completely are urgently required. They should deal with quarters, not halves.

It is a matter for regret that so many tapping experiments are published with insufficient data. It is essential to know the number of trees, average girth, method or pattern of tapping, fraction of circumference operated upon, number of cuts, angle of cut, tapping interval, number of tappings, as well as the total yield. If experimenters would supply accurate diagrams these would furnish much of the information required.

## THE PREPARATION OF PLANTATION PARA RUBBER.

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Two of the principal problems in connection with the plantation rubber industry at the present time are (*a*) the investigation of the most suitable method of preparation of a rubber equal or superior to Fine Hard Para, and (*b*) soil investigations with a view to ascertaining the requirements of the rubber tree, in order to increase or maintain good yields of latex. I refer here particularly to the cultivation of *Hevea brasiliensis*, the Para rubber tree, which constitutes nearly 100 per cent. of the plantation rubber industry. Both problems are now receiving considerable attention from the point of view of scientific investigation in the East—Malaya, Ceylon, and Java. It is unfortunate that, until quite recently, very few investigations of any value have been carried out on tropical soils, since comparison with soils in a temperate climate may lead to erroneous conclusions, especially when we consider the fertility of such soils, which in a temperate climate would be deemed poor. Recent investigations, especially on soil biology and soil physics, will probably be found capable of explaining in many ways the apparent fertility of many tropical soils. Both problems are for the chemist to endeavour to solve. The former problem, however, is more or less new, and one which could not have been completely investigated during the few years since the plantation rubber industry became a commercial success. Perhaps the interest which is now being taken in the subject, particularly in so far as British Colonies and Protectorates are concerned, and the application of scientific methods in the endeavour to obtain a superior product, may be well gauged by the increase in the number of chemists engaged in these investigations, apart from other scientific officers.

During the last three years the number of chemists engaged in research work in connection with the rubber industry in Malaya has increased from one to nine, apart from those employed for special work in England, working more or less in conjunction with the former. Similar if not such pronounced increases in the number of research chemists have taken place in Ceylon.

The investigations already carried out, although many of them are of a preliminary nature, have proved very valuable to the industry and to particular estates.

The problem is a very interesting one, and somewhat different from the usual investigations, in which chemical purity of the product prepared is the most essential point. We have realized for some time that percentage of pure caoutchouc in commercial raw rubber is not by any means the principal object at which to aim. Thus, we may have two samples of raw rubber, *e.g.*, smoked sheet and pale crêpe, in which the actual percentage of caoutchouc is higher in the latter owing to the larger amount of washing and maceration it has undergone, whereas the quality of the former after vulcanization may, and should, be considerably superior to the latter. Investigation is still required as to the reason of this superiority, and this is probably to be found in a study of the protein content and the physical nature of the coagulum, and is known to be dependent on the method of coagulation of the latex and the subsequent treatment of the raw rubber. It appears also, in the light of recent experiments, that the rate of cure, and thus the "coefficient of vulcanization" (*i.e.*, the proportion of combined sulphur to raw rubber in the cured material) is an important factor in the vulcanization of various grades of plantation rubbers and in rubber from different species of trees, and that this coefficient of vulcanization or percentage of combined sulphur depends, *cæteris paribus*, on the nature of the raw rubber. The variability in the plantation product necessitates different rates of cure for different samples in order to obtain the optimum result. If plantation rubber were prepared from all estates in one or two uniform grades, the manufacturer would be able to purchase various shipments which would always behave on curing in a similar way, whereas it is now necessary to carry out preliminary experiments with different batches, which the smaller manufacturers, in the absence of a testing laboratory or scientific advice, are not in a position to do. If it is found impossible to obtain absolute uniformity, as well as superior rubber, from all estates, from "first quality" latex, samples must be tested, graded, and shipped with guarantees or certificates of quality, showing the rate of cure at which the best result is obtained in subsequent tests for elasticity, resiliency, and strength, in order to enable the manufacturer or his agent to purchase according to his requirements. In the absence of such certificates, uniformity is relatively of more importance than actual quality, owing to the absence of a satisfactory method of purchase.

Until the various testing stations which have recently been inaugurated at the Agricultural Department in the Federated Malay States, at the Imperial Institute in London on behalf of Ceylon, and the slightly older station at the Technical High School, Delft, together with the Department of Rubber Testing at the Koniglich Materialprufungsamt in Grosse-Lichterfelde, Berlin, have been at work for some time, the lines along which work must be carried out in the country of origin of the rubber will be the standardization of rubber on different estates, in so far as uniform methods of coagulation, machining, and curing may be adopted. Thus in the case, *e.g.*, of smoked sheets, it would be well if all estates were to coagulate a latex of a standard density reduced by the addition of water under control in the factory where necessary, so that equal volumes of the latex would always yield the same weight of dry rubber; such rubber should be uniform in character. It is impossible to produce satisfactory sheet rubber by the coagulation of pure concentrated latex with acid coagulants of, say, 1 per cent. or 5 per cent. strength, owing to various defects produced in the rubber from comparatively thick latex, so that in the case of pure latex it has to be diluted, or what amounts to the same thing, a large quantity of a more dilute acid coagulant must be added.

I have found that a very satisfactory sheet can be made from latex containing 15 per cent., *i.e.*, 1·5 lb., of dry rubber per gallon. This corresponds to a latex density of 0·9898 at 84° F., and I have found recently, by means of a delicate hydrometer, that sheets from a gallon of such latex can be made very even in weight, the difference being about ½ oz. of rubber per sheet weighing 1·5 lb. in ordinary factory practice.

If the latex varies from day to day it is impossible to obtain uniformity in the rubber, as varying dilution affects the quality of the coagulum. If such dilution to a standard density, although it enables a uniform rubber to be made, is found to produce a somewhat inferior product, other means may be found to improve the quality of such rubber, since the physical properties of the coagulum probably depend on the relative concentrations of the caoutchouc, protein, salts, and added coagulant, or of any one or more of these constituents. This point requires investigation, as it may be found that the addition of a salt or of soluble protein material to the latex before coagulation will improve the coagulum and the rubber after vulcanization.

As far as the primary problem is concerned, *i.e.*, the preparation of the raw rubber, I propose to deal with the problem in a general way in the light of our present knowledge of the subject, and for this purpose shall divide the subject into different sections, treating the various processes in chronological order from tapping and collection of latex to packing, *i.e.*, from the beginning to the end of the history of the sample in its country of origin, in so far as these processes affect the quality of the raw rubber.

### *Tapping and Collection of Latex.*

Experiments have shown that excessive tapping causes not only a reduction in the yield of latex, but a reduction in the caoutchouc content and probably of other constituents of latex—protein, mineral salts, etc. As we know also that dilution of latex produces a weaker coagulum, which has been shown to yield an inferior vulcanized rubber, it follows that excessive tapping will produce an inferior rubber on this same account. The effect, however, may not be very marked, as small dilutions of latex do not show very marked effects. Secondly, in the preparation of sheet rubber it is essential to add a certain amount of water to the latex, in order to avoid certain defects, which, although of no real significance, affect the market price of the commodity. If it is shown that dilution, even to the extent necessary in the preparation of sheet of good even appearance, affects the quality, such dilution will have to be avoided, at the expense of appearance, which is a poor criterion of value.

Only a few remarks need be made on the subject of latex collection, which are really summed up in the word "cleanliness."

Cleanliness in collection and rapidity of collection means more rubber from "first quality" latex, since any extraneous matter or residues in cups may set up fermentation very rapidly and cause partial or complete natural coagulation and a lower percentage of No. 1 rubber.

I would point out here, however, that this naturally coagulated rubber, although it fetches a comparatively low price on account of irregular and general dark colour due to surface oxidation, is probably of very high quality owing to the conditions under which it is coagulated, *i.e.*, a rich concentrated latex containing higher proportions of caoutchouc, protein, salts, etc. The proportion of first quality latex rubber to naturally coagulated lump should amount to between 70 and 80 per cent.

### *Coagulation.*

The method of coagulation is a very important factor from the point of view of the ultimate product, and much remains to be investigated in connection with the underlying causes for the differences obtained under different conditions of dilution and with different coagulants.

I propose to discuss this subject entirely from the practical point of view, and thus to deal with only the principal coagulants which have been or are at present in use.

*Acetic Acid.*—Probably on over 99 per cent. of estates acetic acid is the coagulant employed in the preparation of Pará rubber; its use may be described as a logical outcome of the Amazonian smoking process, since the fumes from the dry distillation or slow combustion of woody material are comparatively rich in this acid.

The proportions used, however, on different estates, especially in the preparation of crêpe rubber, are very variable, and are no doubt one cause of the variability in the rubber obtained.

The writer and other investigators have found that the minimum quantity of pure acetic acid necessary to coagulate an average latex containing about 30 per cent. of dry rubber is 0·1 c.c. per 100 c.c. of latex, or 1 part per 1,000 of latex; this quantity is recommended as the most suitable to use for coagulation. In the case of a latex containing about 1½ lb. of dry rubber per gallon, a 5 per cent. solution of acetic acid in the proportion of 3 fluid oz. of the diluted acid per gallon of latex is recommended for coagulation purposes, both in the preparation of crêpe and sheet rubber, which is an excess on the safe side.

Large quantities have been found to produce a rubber of inferior qualities, although a considerable excess may be used compared with mineral acids, such as sulphuric and hydrochloric acid, without producing such deleterious effects. The abuse and not the proper use of acetic acid is to be condemned.

*Mineral Acids.*—Of the mineral acids, sulphuric and hydrochloric acids may be used, and are more powerful coagulants than acetic acid. Excessive quantities of mineral acids are very deleterious. Nitric acid is not to be recommended on account of its oxidizing action. Sulphurous acid in the form of liquid sulphur dioxide compressed in cylinders may also be used, and, as would be expected, produces a fine pale rubber due to the inhibition or destruction of the oxidizing enzymes normally present in Hevea latex.

Sulphuric acid is used on one estate in the Federated Malay States in the writer's knowledge for the coagulation of latex, the rubber from which is subsequently crêped. If used in minimum quantity, the mineral acids, especially sulphuric acid, produce a rubber not inferior to that coagulated by means of acetic acid. The chief advantage of sulphuric acid is its cheapness, while its disadvantages are its dangerous and corrosive action and the liability to damage the rubber if the coagulation is not properly controlled.

*Other Coagulants.*—A number of salts have been found to act as coagulants, but the quantities required are comparatively large, the rubber does not appear to be superior, and the cost of the coagulant is greater.

Hydrofluoric acid (also sold in dilute solution under the title "Purub" for coagulation) acts as a coagulant, and produces a pale rubber due to inhibition of natural oxidation. This acid is, however, expensive and not convenient to handle, and the pale colour desired in raw rubber for specific purposes may now be obtained by other methods.

Various combinations of salts, etc., have been patented as coagulants and boomed at certain periods, but these have died a natural death.

Formic acid deserves special mention, as, provided the present method of coagulation of Hevea latex by means of acid continues, it appears probable that formic acid may replace acetic acid. As a coagulant it is more powerful, *i.e.*, smaller quantities per unit volume of latex may be used, and the resultant rubber is apparently not inferior to that prepared by means of acetic acid. It has been stated that formic acid can now be prepared at about half the cost of acetic acid, owing to the discovery of new methods and sources of manufacture. At the present time, in the Federated Malay States, it costs slightly more than acetic acid, and I am informed by the firm which first imported this acid that the freight is high, as the shipping companies consider it is a dangerous chemical, hence the higher price charged in this country. It also corrodes the corks of the carboys in which it is contained, and thus the strength of the acid is liable to diminish on storage, especially in the tropics. One estate manager in the Federated Malay States prepares an excellent pale crêpe by using formic acid as a coagulant.

### *Sheet, Crêpe, and other Forms of Rubber.*

In the Federated Malay States almost all the first quality latex is converted into either sheet or crêpe, the former being almost invariably smoked.

The method of coagulation in both cases is essentially the same, since, in the preparation of sheet, if care be taken, the acetic acid coagulant can be added to the latex in bulk, *i.e.*, in quantities of 40 to 50 gallons of latex, and the latter can then be poured into the separate rectangular pans or into larger rectangular vessels divided up by means of movable partitions before coagulation commences. This saves considerable time, and tends to produce a more uniform rubber than the method of adding the coagulant to each separate pan. In preparing sheet, it is necessary to skim the surface of the latex lightly after adding the coagulant and before coagulation commences, in order to remove the froth or air bubbles which are invariably produced by agitating or stirring an emulsion; if this is not done, when the coagulum is subsequently machined, the surface side of the rubber will be covered with films and "pock" marks due to the bursting of these bubbles. The scum thus removed may be added to the cup washings, etc., which are converted into No. 2 crêpe.

In coagulating latex for the preparation of crêpe, quantities of 40 to 50 gallons may be treated in bulk in a similar way, and the lump of rubber formed subsequently cut up with a knife for convenience in handling while passing through the macerating machines. Coagulation is complete within an hour or two when the minimum amount of coagulant is used.

If excess of coagulant is used, as is often done in preparing crêpe rubber, coagulation is almost immediate, but the rubber is likely to be inferior. In the preparation of sheet rubber an excess of acid cannot be used, otherwise it is impossible to obtain sheets free from defects.

### *Machining and Machinery.*

The next treatment undergone by the coagulum is the machining. In small factories on small estates, or when an estate is only just coming into bearing, the rolling is carried out on hand machines. In the case of the lower grades, *e.g.*, tree scrap, and especially bark shavings, hand machines are not sufficiently powerful, as such rubber and débris require considerable maceration and washing. When possible in such cases low grade material is treated on a neighbouring estate till mechanical power is available in the factory concerned.

Before machining No. 1 sheet or crêpe rubber from first quality latex, the coagulum should be allowed to stand from four to six hours after the coagulant is added to the latex. As a general rule it is left overnight and machined the following morning, the lower grades being treated during the afternoon.

On some estates, especially before the use of sodium bisulphite became general, crêpe rubber was prepared from the freshly coagulated rubber by macerating and washing about half an hour, or even less, after coagulation, in order to avoid the darkening due to natural oxidation caused by oxidizing enzymes present in the latex, which proceeds slowly after the latex is collected.

*Sheet Rubber.*—In the preparation of sheet rubber only two machines are necessary, a plain even-speed roller machine in which most of the moisture is pressed from the rubber, and a diamond or a spirally grooved crêpeing machine to mark the plain sheet. Care has to be taken while marking the sheets that the rollers of the crêpeing machines are not too close together, otherwise maceration of the rubber takes place. To those who may not be acquainted with the principle of marking sheet, it may be stated that the sole idea of this ribbing of sheets is to enable the sheets to be more easily separated from each other when removed from the packing cases, as they are not so liable to stick together as in the case of plain sheet.

*Crêpe Rubber.*—In the preparation of crêpe rubber one machine only could be used, namely, a machine with spirally or diamond cut rollers running at uneven speeds; crêpe, however, which is only machined between such rollers is very uneven in thickness, *i.e.*, very corrugated, and dries very unevenly, being thus more subject to spot diseases caused by bacteria and fungi. For this reason crêpe rubber is subsequently passed once or twice between the smooth even-speed rollers of a sheeting machine. In a large factory, however, it is preferable to have a battery of crêpe machines so that the gauge of each is fixed; the fresh coagulum can then be passed a definite number of times through each machine, so that all the rubber gets uniform treatment.

*Worm Rubber.*—This kind of rubber is now rarely shipped; it usually consists of thick crêpe cut into worms by circular knives on a special cutting machine, and subsequently dried in hot-air chambers, such as the "Chula" or "Colombo" driers, or in vacuum chambers.

*Block Rubber.*—Block rubber consists of crêpe rubber, previously cut into worms, artificially dried either in vacuum or hot-air driers, and then blocked under high pressure, say three or four tons per square inch, for several minutes. It is a very convenient form for shipping, and much space and time is saved in its preparation, but we have yet to prove that the rapid method of drying is not deleterious. In any case block rubber is not likely to be superior to ordinary crêpe.

*Lower Grades.*—Till comparatively recently all the lower grades were washed and macerated in an ordinary crêpeing machine; this is laborious, and, in the case of bark shavings which are previously soaked for a day or two in water to soften the wood, much of the fine particles of wood, etc., is actually incorporated with the rubber. During the last two years machines in which the rollers revolve under water have been introduced for the preliminary treatment of this material; in these machines the fine particles of wood float on the water and are carried off through wire gauze, and the heavier débris, sand, etc., escapes below. The best and original type of machine of this kind is the Werner-Pfleiderer Universal Washer, of which there are now several smaller local modifications. The chief drawback of this machine is its size and weight and the large amount of power required; it not only produces a much cleaner rubber from bark shavings, but is more rapid, and requires less attention. The rubber from this machine is subsequently crêped in an ordinary crêpeing machine.

*Defects in Machinery.*—All the machines on estates are adaptations of the washing machines used in the large factories in Europe for washing crude rubbers, but are usually smaller; the chief defects are faulty lubrication methods, whereby oil may come into contact with the rubber, absence of movable guides on rollers, whereby crêpe of any desired width could easily be made, and open worm gearing in the front of the machines, which has to be oiled, and with which the rubber may easily come into contact. Machines appear to have been constructed recently with overhead gearing to adjust the back rollers instead of the front, the latter being fixed; this should be a considerable improvement. The receiving trays beneath the rollers should also be narrower than the rollers, otherwise oil from the bearings is liable to drop into them. Copper rollers should be avoided, since, if soluble copper salts are formed, by allowing them to corrode, the rubber will be seriously and permanently spoilt.

### *Drying of Rubber.*

Three methods of drying rubber, apart from smoke-curing, are in general use in the Federated Malay States: (1) Normal air drying; (2) hot-air drying; (3) vacuum drying.

Methods of drying which involve the condensation of the moisture present in the atmosphere of a drying room by refrigeration processes have not so far been adopted.

*Normal Air Drying.*—At the present time the natural air drying of rubber in the case of thin crêpe appears to be generally quite satisfactory, and only occupies from four or five to about ten days, depending on the thickness and even finish of the rubber. The best estate drying rooms consist of a two-story building in which the No. 1 crêpe is hung on racks in the upper story; the ceiling of the bottom story, which constitutes the floor of the top story, is constructed of open broties or strips of wood, at any rate under the racks in the top story, leaving only sufficient passage room between each set of racks; ventilation is improved by means of a jack-roof or ventilating shafts. The drying sheds are usually built of corrugated iron, and, unless they have a high roof, the latter should have a wooden ceiling beneath the iron. Usually the bottom floor is used as a packing room, and frequently the lower grade crêpes are suspended from the open boards of the ceiling of this bottom story. In no case should a drying room be immediately over the washing factory, and preferably not running along the length of the factory in the case of a one-story combined factory and drying shed, unless the floor of the former is so constructed that no water can possibly drain towards the drying room, since such drying rooms would be continually damp, and spot diseases due to the growth of fungi and bacteria would be prevalent. A drying room should be preferably quite a distinct building; no sunlight should be allowed to come into direct contact with the rubber, otherwise tackiness occurs, so that all windows should be protected with red or yellow cloth, which allows the passage of air, but shuts out the direct rays of the sun.

In my opinion, drying rooms and smoke-rooms should be divided into compartments, since the introduction of wet rubber into a room containing partially dried rubber retards the drying of the latter considerably.

*Hot-air Drying.*—Three systems are in use in the Federated Malay States: (*a*) Chambers, such as the Chula and Colombo driers, in which the hot fumes of combustion of ordinary wood or other fuel are passed through pipes leading through the chambers in which the rubber is hung or spread on racks; (*b*) large steam pipes through which steam at ordinary pressure is passed, and over which the air passes before reaching the rubber; (*c*) narrow steam coils through which steam under pressure of about 60 lb. per square inch is passed, the air entering below the pipes and being heated by them before passing through the rubber. In each case an exhaust fan or a forcing fan is used to circulate the air more rapidly. The two latter processes are at present in use by the Department of Agriculture, Federated Malay States.

*Vacuum Drying.*—At present this process is only used on one or two estates in Malaya, one being an estate on which vacuum-dried crêpe is subsequently blocked.

The chief drawback to the use of vacuum driers or hot-air driers is that the temperature must be carefully regulated, especially towards the end of the drying, to avoid tackiness. With vacuum-dried crêpe it is usual to pass the rubber again through the washing rollers after drying; only surface moisture is then taken up by the rubber, which can be quickly dried in an ordinary drying room. The chief advantages of artificial methods of drying are rapidity in drying, economy in space, and absence of " spot " diseases.

No satisfactory vulcanizing experiments appear to have been carried out so far to test the value or otherwise of any of these processes, but experiments will be carried out shortly at the Department of Agriculture, Federated Malay States.

Before passing from this subject another process offers interesting possibilities, namely, drying in the presence of carbon dioxide. This may be carried out in an ordinary two-story building similar to the smoke-houses in common use, charcoal fires, instead of the usual fuel, being used in the fire-boxes. The atmosphere of carbonic gas inhibits the slow natural oxidation which continues during the drying of the rubber and prevents the growth of the usual chromogenic organisms, which are aerobic.

It might be stated here that these statements refer to the drying of crêpe rubber, since no unsmoked sheet is now made on the larger estates; there is, however, no difference in method, the only difference being in the distance between the racks which hold the rubber.

### *Smoke Curing of Rubber.*

Smoke curing of plantation rubber probably had its origin as an imitation of the Amazonian smoke-curing process, and the recent vulcanizing tests carried out by Messrs. Beadle and Stevens on behalf of the Rubber Growers' Association appear to have proved definitely that the smoking of plantation sheet or other forms of rubber does undoubtedly in some way improve the physical properties of the rubber to a marked extent. Whether the results obtained depend on one or more of the constituents of the fumes from the fuel, to the elevated temperature in the presence of an atmosphere deficient in oxygen or rich in carbon dioxide, or to the preservative action of the fumes, due to some particular constituent of the smoke, on the protein material in the rubber, remains to be investigated.

The form of rubber smoked now is almost entirely sheet; the demand for smoked crêpe has ceased, due possibly to the fact that lower grades of rubber could, by being smoked, be made to resemble closely first-grade crêpe, the various defects being obscured by the dark colour of the smoked product. The best type of smoke-house is the two-story building, resembling the Kent hop kiln or drier; the sheets of rubber are hung on racks in the top story and the fuel burnt in a hole in the ground of the bottom floor, or preferably in shallow fire-boxes on wheels. A wire-gauze box should be placed over these fire-boxes to retain dust and sparks, or wire gauze may be placed in the openings below the rubber racks. A maximum and minimum thermometer should be kept in the top story as a check on the temperature; if the temperature rises above 120° F. during the day smoking should only be carried out between 4 p.m. and 9 a.m.

Sheet of average thickness (about $\frac{1}{8}$ in.) is completely dried in from ten to fourteen days, but smoking may be carried beyond this period and, according to tests carried out by the chemists of the Rubber Growers' Association, appears to improve the quality of the rubber. Fairly dry jungle wood or wood mixed with coconut husks provides a suitable fuel; if the latter alone is used the rubber has the appearance often attributed to "over-smoking," as the fumes are rich in tarry and creosotic substances.

### *Other Processes of Preparation.*

I propose in this section to deal briefly with four of the principal processes which have been tried on a more or less commercial scale and which appear to be promising in several ways. These processes are all imitations of the Amazonian smoke-curing process and are as follows: (1) Derry's process; (2) Wickham's process;

(3) Byrne's process; (4) coagulation of latex in shallow trays in a smoke-house, devised by the writer and since by others.

*The Derry Process.*—This process was originated by Mr. Derry, late Curator in the Botanic Gardens, Singapore, and was first worked successfully by Mr. Barrowcliff, First Assistant Agricultural Chemist, Department of Agriculture, Federated Malay States, on behalf of a Committee appointed by the Government to investigate the process. The principle of the process depends on the coagulation of thin films of latex on a revolving belt. The present apparatus consists of two belts, each 40 ft. long, which are worked by hand and made to revolve in a long smoke chamber. The smoke is generated in an outside furnace and passes into a large pipe on the floor of the building, thence into a smoke-box and through perforated pipes placed immediately under the belts and extending nearly the whole length of the belts. The belts are passed over rollers at each end, with gearing and mechanism to tighten and raise them, and are slightly inclined to the horizontal. Latex is placed in shallow trays on tables which can be raised and lowered by means of a screw; the tables are raised so that the latex in the trays just touches the belts by capillary action and a very thin film is thus taken up. The tables are placed under the rollers, *i.e.*, at the lowest end of the belt just outside the smoke-room, as it would be difficult to operate inside the room. When properly working, one revolution of the belt through the smoke chamber is sufficient for each film of latex, so that the latex can be continuously taken up by the belts. Two very essential factors, on which the success of the process depends, are dry fuel and concentrated latex containing over 25 per cent. of dry rubber; with the present apparatus a strong breeze is found to be disadvantageous. The rubber is allowed to remain on the belt overnight, stripped off the following morning and rolled together; if necessary it can be allowed to hang for a further period in the smoke-house, but it is not known whether this improves the quality further. The maximum output per belt is about 15 lb. for a period of six hours. The process can probably be improved in several respects, and experiments will be carried out shortly to test the increased efficiency by: (1) Enclosing the greater part of the belts in long boxes with hinged doors; (2) use of an exhaust or forced draught fan; (3) graduation of the holes in the perforated smoke-pipe, since with large holes of the same size the smoke escapes through the first few and only acts on a short portion of the belt; a fan would also improve the apparatus in this respect. On a large scale some forty or fifty belts could be run by means of a small engine running at low speed and geared very low.

*Wickham's Process.*—Wickham's process, advocated for several years by the inventor and recently taken up by a company for working on a commercial scale, is very similar to Derry's in principle, except that the latex is spread over the interior surface of a hollow drum into which smoke from a furnace is passed.

In both the Derry and Wickham processes, unless some means is adopted to prevent natural coagulation, such as the addition of formalin to the latex, a considerable amount of naturally coagulated lump is formed unless a sufficient number of belts is available to treat each day's yield of latex in two or three hours.

*The Byrne Process.*—The Byrne process, which has been boomed considerably during the last year, and is being adopted recently on a number of estates in Malaya, differs from the preceding two in that it is not a process for coagulating latex direct (N.B.—It could be adopted for this purpose, *vide* next process), but a more rapid and possibly constant method of smoking rubber coagulated by acetic acid or other coagulants in the ordinary way. The rubber in the form of crêpe or sheet is hung on racks in a single-story smoke chamber, the walls and roof of which are covered with "malthoid" or similar material. The process consists in dropping at equal or any desired rates two fluids, known as Amazonian No. 1 and No. 2, on to a hot plate, which forms the bottom of an oven in the machine constructed and sold on behalf of the inventor; the plate is heated by means of a blast kerosene oil lamp, charged from a reservoir attached to the machine. The two liquids, which consist essentially of crude tarry and creosotic substances and pyroligneous acid respectively, are vapourized by dropping on the heated plate, and the vapours produced are led through a pipe into the smoke chamber. The period of treatment is only two to four hours, after which the rubber may be hung for twenty-four hours and shipped without further drying, or it may be hung to dry in an ordinary drying house before dispatch. When this machine was first introduced it was used for the smoking of crêpe rubber, but the demand for this having ceased, and the fact that the process was not taken up to any extent, due probably to the royalty charged by the inventor or the syndicate holding the patents, has caused the adoption of different ideas, the most important of which is the smoking of "slab" rubber. Latex is coagulated by the ordinary method used in preparing sheets in rectangular troughs or trays; the thick, soft slab of rubber is then lightly hand-rolled and is placed immediately in the curing shed, lying flat on the shelves or racks, smoked for two and a half to three hours by means of the fumes from the Byrne machine, turned over and smoked the following day for a similar period, and then allowed to dry without further treatment. The idea is a step in the right direction; but, except for rapidity, it is probable that slab similarly treated in an ordinary smoke-house would produce a rubber possessing equally good physical properties.

A Byrne machine has been lent to the Department of Agriculture, Federated Malay States, by the Syndicate, and experiments in several directions will be carried out shortly, such as the utilization of the fumes for curing latex on belts in the Derry process, and the coagulation and curing of latex in shallow trays in the curing shed. The racks in the curing house are being erected on wheels and placed on rails so that they can be removed easily from the curing house for loading and unloading.

*Smoke Coagulation of Latex* (*Author's Process*).—Experiments were first carried out in 1911 with the idea of coagulating latex in thin layers in shallow trays in an ordinary smoke-house, but were only carried to a very preliminary stage at that time, as it was considered desirable to wait till samples could be vulcanized and tested by the Department. Towards the end of last year and early during the present year (1914) the experiments were carried a step further and a number of shallow trays utilized for the purpose in a "Jackson" smoking cabinet, which is essentially a small smoke-house with walls and roof of galvanized iron, with a small furnace below in which compressed coconut fibre, especially treated by the inventor, is burnt. The fumes are very rich in creosotic vapours and cause a very rapid smoked appearance in ordinary sheet and crêpe rubber. It was found possible to coagulate layers representing a pint of pure latex in trays 24 in. by 9 in. in twenty-four hours or less. These trays should be constructed not more than 1 in. deep and placed in tiers with about ½ in. space between each tier and ½ to 1 in. space between each tray in any one tier, in order to give sufficient space for the smoke to pass. If the space thus left is insufficient for a good draught an exhaust fan could be employed. Pure latex containing 25 to 30 per cent. of dry rubber, or, say, 2·5 to 3 lb. per gallon, should be used, as there is less water to evaporate and coagulation takes place more readily. The capacity of chamber required can easily be calculated for any daily yield of latex. Thus the actual cubic content required per pint of latex on the above assumption would be 480 cub. in. with trays 1 in. deep, allowing 1 in. space between each tier of trays and 1 in. between each tray, or, say, 2¼ cub. ft. per gallon of latex, *i.e.*, a chamber 5 ft. square and 9 ft. to the eaves would be sufficient for 100 gals., or, say, 300 lb. of dry rubber per day. A number of small cabinets would probably be preferable to one large chamber. It may be found possible to coagulate a deeper layer of latex than is represented by a gallon of latex spread over an area of 12 sq. ft., in which case a large volume of latex could be treated at the same time in a chamber of the above size.

Each layer of latex in a tray is smoked for twenty-four hours or less, and the following day a similar layer is added, the addition being continued till the trays are full, which takes from one to two weeks, according to the depth of tray used.

The rubber is then removed from the trays and may be pressed into blocks; as in the case of Fine Hard Para, it contains from 10 to 20 per cent. of moisture, and the inner layers are white till exposed subsequently to the atmosphere. The exact depth of tray which is most convenient has still to be ascertained; the shallower the tray, within limits, the greater is the quantity of latex which can be treated on any one day, since more trays can be used in a smoke chamber. The chief drawback to the process is the number of trays required; economy, however, can be effected by using comparatively large trays. The advantages of the process are: (*a*) The fact that the rubber need be handled only once in a week or fortnight when removed from the trays; and (*b*) the rubber will probably be very uniform throughout, since, unlike rubber made from the latex on any one day, which may vary from day to day, the daily variations will be corrected in a slab or sheet which is formed from latex obtained daily over a period of, say, seven to fourteen days. The uniformity appears to the author to be the most important point in connection with the process, and probably explains the greater uniformity in Fine Hard Para, each ball of which is prepared from latex collected over a prolonged period.

Since these experiments were commenced by the author a patent has been applied for in Malaya by another experimenter who has evidently been working on similar lines. It is not possible at present to say definitely whether the process will work satisfactorily on a large scale, as, in the author's experiments, only about twelve trays were used in the smoke cabinet employed. Experiments on a larger scale will be conducted shortly and the samples vulcanized and tested.

### *Defects in Raw Rubber and their Remedy.*

The principal defects to which objection is taken by buyers are the following: (1) Tackiness; (2) spots due to fungi and bacteria; (3) oil marks; (4) holes in crêpe; (5) yellow patches in pale crêpe; (6) over-smoking; (7) dark colour in unsmoked rubber; (8) rust marks.

*Tackiness.*—As far as our present knowledge goes, tackiness is due to one of three causes: (*a*) Action of certain salts, *e.g.*, salts of copper and iron; (*b*) sunlight, which may be due to the heat effect, or to the light effect due to the actinic rays; (*c*) direct heat.

Salts of copper are known to be very deleterious in their action on both raw and vulcanized rubber; the action is an oxidation process, and the rubber increases in weight, softens, and eventually becomes brittle. On this account copper or copper-covered rollers, such as are often found on hand machines, should be avoided, as, unless kept scrupulously clean, "verdigris" forms and may be incorporated with the rubber. Oil containing brass from old or overheated bearings may constitute a similar source of danger, but not a very probable one. Tropical sunlight causes tackiness in rubber, as experiments by the author have proved, but whether this was due to the actinic rays or to the heating effect was not definitely proved: this point will be tested later, also the action of sunlight and heat in the presence of inert gases, such as carbon dioxide and hydrogen. That tackiness may be caused by heat alone can easily be shown, and it has been known to occur in rubber hung near a boiler in an estate factory. Vacuum-dried rubber and rubber dried in hot-air chambers at about 130° F. exhibit tacky surfaces, and the deleterious effect produced by these methods of drying are invariably caused by the excessive heat.

*Spot Disease.*—Spot diseases have been proved by a number of investigators to be due to micro-organisms, fungoid or bacterial in nature, and are of sufficient interest and importance to merit separate treatment, but in a paper of this nature they can only be discussed somewhat briefly. The cause of such spots are airborne spores of the micro-organisms which gain entrance into the latex in the cups in the field, or may be deposited on the wet, freshly machined rubber in the factory or drying room. Any process which tends to retard the drying of the rubber is conducive to the development of the spores, several of which are chromogenic fungi and bacteria, causing yellow, black (blue in transmitted light), orange, or red spots. The use of sodium bisulphite in the preparation of rubber, which by chemical action is partly converted into the hygroscopic magnesium salt in the latex, and the preparation of blanket or thick crêpe, which dries slowly, almost invariably result in the development of these spots, and were probably the cause of the somewhat widespread epidemic during 1911 in the Federated Malay States. Spot diseases, as would be expected, are very prevalent in unsmoked sheet and in rough crêpe on the thick ridges made by the diamond or spirally cut rollers of the crêpeing machines, which do not dry as quickly as the thinner portions, hence the advantage of "finishing" crêpe on smooth, even-speed rollers. Under ordinary circumstances, if no development of the "spots" occurs during the first day or two after the rubber is hung in the drying room, the rubber is safe from further attack. The spores, however, may still be present and, as these may be very resistant to desiccation, further development can take place if the rubber is allowed to become moist again. Three very interesting cases in which such subsequent development has occurred have come to the author's notice. In the first two instances samples of rubber which had been sent to Europe from estates were returned to the managers and sent subsequently to the Agricultural Department for report in connection with orange spots on the specimens; the managers of the estates in question stated definitely that the rubber, when packed and shipped, was perfectly dry and showed no trace of such spots. On microscopical examination the spotted portions of the rubber were found to contain numerous spores from which short hyphæ had developed, further development appearing to have been arrested. It could only be surmised that the cases of rubber had subsequently come into contact with water, probably accidental contact with sea water. This idea was amply confirmed in connection with a case recently examined by the author. The rubber in question was received from an estate for dispatch to the London Rubber Exhibition and examined by the Director of Agriculture and myself among other cases before dispatch. The case was returned shortly afterwards by the shipping agents, as it had fallen from the "lighter" at the Federated Malay States port in course of removal from the jetty to the ship. Although the sample showed no trace of spot disease when first inspected and was perfectly dry, after reopening it was, as would be expected, very moist, with the characteristic translucent appearance of rubber which had never been properly dried; and, secondly, a "pink" spot disease had developed to a marked extent throughout the sample. It was exceedingly improbable that the spores had gained entrance subsequently, since the development had occurred on rubber in the centre of the case as well as on the outer pieces of rubber, and was evidently due to the subsequent growth of resistant spores originally present in the rubber which developed on account of the suitable moisture conditions now present; the salts in the sea water naturally assisted in keeping the sample moist. In the third case, to which a similar accident had befallen, the rubber was becoming very heated owing to fermentation (N.B.—The rubber consisted of lower grades, bark, scrap, etc., containing a comparatively large percentage of extraneous matter) set up probably by micro-organisms or their enzymes, on account of suitable moisture conditions. As would be expected, these micro-organisms develop readily in freshly machined rubber which is rolled together, since the moisture escapes more slowly then when the rubber is hung or placed immediately on racks. Mr. Sharples, Assistant Mycologist in the Department of Agriculture, Federated Malay States, has found the addition of formalin to the latex to be of great value in reducing the development of these fungi and bacteria; the formalin is retained in sufficient quantity in the machined rubber, even in crêpe which is subjected to much washing, either by adsorption or combination possibly with the protein constituents. Drying in an atmosphere of carbon dioxide may also be recommended, and may be carried out, as suggested before, by burning charcoal fires in the drying room, since most, if not all, of these organisms are aerobic, *i.e.*, unable to live in an atmosphere deprived of, or deficient in, oxygen. In the case of sheet, smoking has the desired effect. The impression is held by some planters and others that micro-organisms do not develop on smoked rubber unless the latter has not been smoked sufficiently; the idea is, however, quite erroneous, since common mildews readily develop on smoked sheet if the latter is kept subsequently in a damp place or wrapped in certain paper, *i.e.*, newspaper or common brown paper.

*Darkening due to Oxidation.*—Numerous experiments by various investigators have proved beyond doubt that the more or less rapid darkening which takes place in Hevea latex, and more markedly in other latices, such as that of Castilloa, on standing and in the rubber after coagulation, both before and after washing, is due to oxidation caused by an enzyme which may be classified as an oxidase, and which is a normal constituent of the latex. The darkening occurs to a marked extent on the surface of the latex or coagulum, due to contact with atmospheric oxygen. Some coagula after standing overnight in the serum have quite a mauve-grey surface. The oxidizable substances in the latex on which the enzyme acts are probably phenolic in character and may be in combination with the proteins. I have shown, by the addition of certain phenols, such as ordinary phenol (carbolic acid) and hydroquinone, to the fresh latex as it exudes from the cuts on the tree, that excessive darkening is caused by an increase of such substances in the latex or in the sap from the cut tissues with which the exuding latex comes into contact; the exact cause of such increase at particular periods is unknown.

The older remedies for inhibiting the oxidation in the preparation of pale crêpe were: (*a*) Immersion of the freshly machined and washed rubber for a short period in nearly boiling water; this destroys the enzyme and prevents further darkening during the drying stage; (*b*) coagulation of the latex with an excess of acid, producing rapid coagulation, and immediate maceration and washing of the coagulum; (*c*) steaming the latex; (*d*) in the case of sheet, covering the coagulum in the coagulating pans, shortly after coagulation is complete, with boards and weights, so that the coagulum is forced beneath the surface of the serum or residual liquid.

Drying in an atmosphere of carbon dioxide may also be adopted to arrest the further oxidation which takes place during the drying of the rubber. The present practically universal method adopted in Malaya is the use of sodium bisulphite. This is added to the latex and thoroughly mixed with it immediately before the addition of the acid coagulant. The use of sodium bisulphite powder or very strong solutions not properly mixed with the latex will cause streakiness or yellow and white patches.

The proportion of sodium bisulphite required varies somewhat with the latex, since some latices, especially from older trees, oxidize rather rapidly and to a greater extent. The amount usually found sufficient is $\frac{1}{10}$ oz. per gallon of latex, or, say, 2 oz. of a 5 per cent. solution per gallon. The chief disadvantage of this chemical is that it retards the drying of the rubber, due probably to the formation of the hygroscopic magnesium salt formed by interaction with the magnesium salts present normally in latex; this retardation is not of great importance in the case of thin crêpe. Sodium bisulphite in smaller quantities is valuable in preventing the rough surface on sheet due to oxidation films and thus improves the appearance of smoked sheet; the sheet takes longer to darken, and thus the appearance of "over-smoking" is also avoided by using small quantities of this salt in the preparation of smoked sheet. According to vulcanizing experiments and tests carried out by the chemists of the Rubber Growers' Association there is no deleterious action on the rubber in using this salt.

*Oil Marks.*—Oil marks are not an uncommon fault, especially in crêpe rubber, the oil being taken up from the sides of the rollers or from the trays beneath; this may be due to careless lubrication of bearings on the part of the operator, or excess of oil on the bearings, which drops into the trays beneath, which are usually made too wide, extending not only the width of the rollers, but also partly under the bearings. An excellent method, by which only the central portion of the rollers form the working part, is to have movable guides placed over the top, which fit over the rollers, such as are found on calendering machines in the large factories in Europe. Crêpe of any desired width can then be made.

*Holes in Crêpe.*—The presence of holes in crêpe, which apparently reduces its market value solely on account of the fact that the rubber is bought on appearance, is really due to not finishing the rubber on smooth rollers; the rubber should be folded on itself so that the holes are closed up during the final finishing process.

*Yellow Patches in Pale Crêpe.*—In the pale crêpe now made by the addition of sodium bisulphite, the mottled yellow and white appearance is usually due to adding the solid substance or a concentrated solution which is not properly mixed with the latex, or possibly through the addition of the bisulphite salt after the coagulating acid, so that proper admixture becomes impossible.

*Over-smoking.*—The appearance attributed by buyers to "over-smoking" may be caused by prolonged smoking after the rubber is dry, a process which has been recommended by the chemists of the Rubber Growers' Association as improving the quality of the rubber, or it may be due to the use of a fuel, the fumes from which are rich in tarry products, such as coconut husks; in the latter case a mixed fuel should be used.

### *Packing of Rubber.*

Although it is difficult to give any satisfactory advice on the subject of packing, it is undoubtedly a fact that even the best of the present cases, such as the Venesta case, is unsatisfactory for the higher grade plantation rubbers, which ought not to require rewashing in the home factory. The unpacking recently of a large number of samples of rubber contained in a number of different cases, received from estates for the London Rubber Exhibition, has demonstrated the fact that even with the greatest care a considerable amount of sawdust, fine splinters, and débris becomes incorporated with the rubber, which must in many instances necessitate the rewashing and maceration of rubber which had been packed in a perfectly clean condition on the estate. This not only entails more expense, but is likely to still further deteriorate the rubber on account of the extra milling it must undergo.

A parchment or waterproof paper, which will not adhere to the rubber during its transport, is required for the purpose.

*Concluding Remarks.*

Although this paper has touched briefly on the various methods which should be adopted in the coagulation of the latex and the preparation of the rubber from the Para rubber tree, it does not pretend in any way to be the final word on this interesting problem, nor has it been possible to discuss in it any theory which may form the basis of the differences between the "ne plus ultra" product of the industry, viz., Fine Hard Para, and the various grades of plantation Parà rubber. Although a considerable amount of work remains to be done, the next few years should enable us to ascertain the cause of any inferiority in the plantation product, and to remedy such cause, at any rate, in the output of our highest quality material. There must, and always will be, different grades and qualities, but the object of the planter and his advisers must be to see that each grade is purchased on its real merits and not on account of some fancy on the part of the buyer. This will be also to the real advantage of the manufacturer, especially the smaller firms which may be unable to afford the upkeep of a research laboratory and one or more research chemists, although the former should form an integral part of any factory dealing with a complex industry, such as the vulcanization of raw rubber, and would be certain, if properly conducted, to far more than pay for its initial cost and upkeep, in enabling the manufacturer to avoid the losses which must occur through the spoiling of large batches of material on account of differences in the raw material which necessitate different treatment during the processes of mixing and curing. Unfortunately, it has been impossible to include in this paper the results of any vulcanization tests carried out at the Department of Agriculture in the Federated Malay States, since these are not sufficiently advanced. No satisfactory tests on raw rubber which have so far been accepted are of any use in enabling authoritative statements to be made as to the value of different methods of coagulation and curing; nor is the market value, which at one period fancies crêpe and at another smoked sheet, any criterion, since these values depend possibly on supply and demand for different grades for specific purposes and the fancy of the buyer.

## SPOTTINGS IN PLANTATION RUBBER DUE TO FUNGI.

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Spottings or discolorations in plantation rubber have been attributed to many causes since the beginning of the plantation industry. It was obvious from the first that micro-organisms were the cause of certain types of spots, and various suggestions were made as to the causal organisms. Ridley suggested that *Protococcus nivalis*, an alga responsible for "red snow" in Europe, might be the cause of the red spots. Brooks later reported from Sarawak that he obtained *Bacillus prodigiosus* from crimson spots on crêpe rubber. The moulds, which develop so readily on the surface of badly dried rubber, were recognized from the first, but were not considered responsible for any of the internal growths.

About the year 1910 the spottings became epidemic in character in Malaya. Even last year (1913) spotted rubber was very commonly met with. The epidemic character of the outbreak necessitated closer investigation, in order to determine the true cause and the methods of prevention.

Bancroft first demonstrated the mycelium of fungi in spots taken from infected samples. Later he performed inoculation experiments in two cases, proving that the spottings could be reproduced artificially by inoculating latex with spores obtained from pure cultures. Further isolation experiments conducted by Bancroft led him to suggest three other fungi as causes of spottings, but no inoculation experiments were performed with these three fungi. The following work was carried out in order to gain fuller information regarding the cause and methods of prevention.

The method of procedure may be summarized as follows:—

(1) To determine the presence of fungi in the spotted rubber by means of a microscopical examination.

(2) To isolate the fungi from the rubber under microscopical control and to obtain pure cultures.

(3) To inoculate, artificially, known amounts of latex with spores developed in pure culture in order to reproduce the spots artificially in the laboratory.

(4) To isolate the fungi from the artificially produced spots.

The following investigation shows that the latex is naturally inoculated in the field. Therefore, care must be taken in deducing conclusions from artificial inoculations, for it is almost impossible conveniently to prepare a sterile latex. In this connection it is obvious that supplementary observations will be most valuable, especially those demonstrating characteristic features of the fungi *in situ* in the rubber. Too much reliance, however, cannot be placed upon the characters of the fungi in pure culture, for they vary to a large extent according to cultural conditions.

The defects of plantation rubber due to the action of fungi may be distinguished as of two kinds:—

(*a*) Spottings, where the discoloured area is usually small.

(*b*) Flushes, where there is a broad, diffused patch of coloured rubber.

Spottings are best observed in crêpe rubber, whilst flushes are more common in light-coloured sheet rubber.

Four specimens were selected for investigation; in each case the life-history of the causal fungus was followed in pure culture.

### (1) *Yellow Flush in Sheet Rubber.*

This flush appeared in sheet rubber which had been coagulated with sodium bisulphite. A fungus, *Penicillium maculans* (nov. sp.), was isolated from the discoloured rubber, and inoculation experiments carried out with spores obtained from pure cultures proved this fungus to be the cause of the discoloration. Rubber samples prepared from artificially inoculated latex coagulated with a mixture of 5 per cent. acetic acid and sodium bisulphite developed the typical yellow colour three days after coagulation, whilst controls prepared at the same time were quite clean.

### (2) *Violet Flush in Sheet Rubber.*

This flush was present in the sample of sheet rubber showing the yellow flush described above, and was investigated because Bancroft suggested *Bacillus violaceus* as the probable cause. A preliminary examination showed hyphæ running through the discoloured area.

This flush did not appear to be a common one, and even when present was never prominent. Isolation experiments resulted in a species of *Fusarium* being obtained in pure culture, and artificial inoculations proved this fungus to be the cause of the violet discoloration.

The investigation of this fungus brought forward a point of some importance. During one series of inoculation experiments with this fungus the artificially inoculated latex was allowed to stand overnight in covered dishes. The following day, on examination, several violet patches covered with a dense growth of white mycelium had developed over the surface of the coagulum. One of these patches was cut out and examined, when the violet colour was found to be due to a layer of typical violet Fusarium spores which had developed over the surface. Thus the typical violet spores were in process of formation eighteen to twenty-four hours after inoculation, when undiluted latex was used as a growing medium.

In pure culture, however, the typical violet spores do not appear till a considerable time has elapsed. In damp chambers kept under observation for three weeks this type of spore was never formed, and in slant cultures ten days passed before the violet spores appeared. During this intervening period the spores produced were abstricted as single cells, which never developed into the typical Fusarium spores. Thus, comparing the life-cycle when grown in latex and in pure culture, there is a distinct type of spore interpolated in the life-history when the fungus is grown under favourable conditions. When growing in latex the life-cycle is shortened by the cutting out of the first stage seen in pure culture. Any shortening of the life-cycle may be taken as indicating relatively poor conditions of growth. Therefore, undiluted latex must be considered as a comparatively unsuitable medium for the growth of fungi.

### (3) *Black Spots in Thin Crêpe Rubber.*

A yeast-like form of fungus was isolated from the spots, and inoculation experiments proved this fungus to be the cause. The fungus was named *Chromosporium crustaceum* (nov. sp.).

Comparisons of the mycelium seen *in situ* and in pure culture showed the two to be identical, this observation, therefore, supporting the inoculation experiments.

### (4) *Blue-black Spotting in Crêpe.*

From this spot a green mould-like fungus, *Trichoderma koningi* (Oudem.), Oudemans et Koning, was isolated. Inoculation experiments indicated that this fungus was the cause of this spotting, but later observations made this conclusion appear doubtful. The spot is very common in this laboratory, and in later experiments always appeared first upon samples of rubber dried slowly, prepared from latex which had not been inoculated artificially. Thus the spots developing in the inoculated samples may have been due to spores already present in the latex, although the controls in these experiments were quite clean.

Further observations were made upon opaque spots developing in unsmoked sheet rubber coagulated with acetic acid. These spots appear very common and suggest bacterial colonies growing in the rubber. However, hyphæ can easily be demonstrated in the spots. There appeared to be some connection between these spots and *Eurotium candidum*, Speg., which always develops on badly dried rubber. No success was obtained by artificial inoculation experiments.

Isolation experiments were conducted in connection with several other spots, usually resulting in *Penicillium* or *Eurotium* spp. being obtained in pure culture. Though no further inoculation experiments were performed the writer concluded that the majority of species of fungi causing spots in plantation rubber fall in these two genera. This is not greatly in evidence in the work described above. The work of O. T. Faulkner, B.A., Mycologist to the Rubber Growers' Association, however, proves the validity of the above conclusion. During the course of this work Faulkner published two private and confidential reports, entitled "Spot Diseases in Pale Crêpe." To that author I am indebted for the following information: "Five species of fungi were used successfully in artificial inoculations; three were species of *Penicillium;* of the remaining two, one was a species of *Eurotium* and the other *Trichoderma koningi* (Oudem.)."

Bancroft has also proved by artificial inoculation that *Monascus heterosporus*, Schrœter, was the cause of a red spot in rubber. The writer has seen the fruit bodies of this fungus *in situ* as described by Bancroft, so confirming the original observation. Also, Bancroft proved that *Bacillus prodigiosus* can produce a discoloration in rubber.

Thus, of the species of fungi shown to be concerned with spottings, the large majority fall in the two genera *Penicillium* and *Aspergillus* (*Eurotium*). There are a large number of species included in these two genera which form a large proportion of those important economically, being useful in the arts and manufactures because of the changes which are brought about as a result of the specific enzymes they are capable of producing. The yeast family is also well known in this respect, and the yeast-like form of *Chromosporium crustaceum* is significant. Therefore, the fact that specific enzymes might play a part in the economy of this problem may be anticipated, and although time would not allow any work to be performed upon this point, the assumption of the presence of specific enzymes produced by these fungi aids greatly in the attempt to account for many of the points elucidated during the investigation.

*Preventive Measures.*

The fact that spottings and discolorations can be reproduced artificially by adding spores to the latex indicates that inoculation naturally takes place during the period elapsing between the tapping of the tree and the coagulation of the latex. Later experiments show the difficulty of external inoculation after preparation.

Thus the direct method of prevention appears to lie in the sterilization of the latex. Formalin in the proportion of 1 part in 800 parts of latex is very useful in preventing the appearance of the spots. Experiments carried out on estates, however, show that when formalin is used to sterilize latex there is nearly always a very small proportion of rubber which still develops spots. Probably the formalin does not kill the spores, but merely inhibits their development, so that the rubber is almost dry before enough mycelium is produced to show visible spots. With thin pale crêpe rubber, in which the spottings prove most troublesome, there ought to be no difficulty in drying the rubber so quickly that, with the addition of the small amount of formalin indicated to the latex, spots are prevented from developing.

Sodium bisulphite also is useful, when added to latex in the right proportions, in preventing spottings in thin pale crêpe rubber. Care must be exercised, for if larger quantities than necessary are added, especially when acetic acid is used in coagulating the latex, the chances of the fungi developing are considerably improved, owing to the slower drying of the rubber. The spotting of thin crêpe rubber on one estate was completely eradicated by adding to 50 gallons of latex 5 oz. of sodium bisulphite in 5 pints of water. The rubber at the same time was worked as thin as possible.

*External Inoculation in relation to Spotting.*

The question as to whether spottings can arise through spores germinating on the surface of the rubber after preparation need not trouble the estate manager whose drying shed is ordinarily effective. Under extraordinary conditions of retardation of drying it is possible for spores to germinate upon the surface, the mycelium ultimately growing into the rubber and causing characteristic spots. But it is unnecessary to isolate spotted rubber from factories in order to prevent the spots spreading from the infected to the clean sheets. However, if the drying shed becomes congested so that the spotted rubber is in contact with the clean, the former ought to be removed to facilitate the drying of the remainder.

### *Dilution of Latex in relation to Spotting.*

Planters assert that there is a great increase of spotted rubber during rainy weather. Experiments were conducted to test this view. Rubber samples prepared from latex diluted with varying amounts of tap-water and distilled water always showed a greater tendency to produce spots than samples prepared from undiluted latex. This is not surprising when the facts are taken into consideration.

Evidence has been brought forward to show that undiluted latex is an unfavourable growing medium for fungi. If latex is a good medium the tapping of the tree provides the opportunity required by many fungi to enter the tissues and to cause diseases. If such is the case there would be far more trouble with *Diplodia cacaoicola,* the common "die-back" on *Hevea brasiliensis,* than there is at present. Not only this fungus, but many other "wound parasites" would find their way into the tissues of the tree. Latex diluted with water, however, is probably a much better growing medium. Addition of water to latex means: (1) Closer approximation to a neutral solution; (2) changes and solution of some of the protein materials; (3) quicker development of acidity which up to certain limits increases the chances of germination of the spores. All these factors favour the development of the spores and give the fungi a much better chance of development.

*Final Considerations.*

Thus there is no room for doubt as to the causes of spottings and discolorations in plantation rubber. Common saprophytic fungi are the chief causes; however, the number of these fungi causing spots is comparatively small. The factor limiting the number of such fungi capable of growing in rubber is probably the absence of a specific enzyme which is capable of rendering the food materials in latex more readily available. The proteins in rubber probably form the food material upon which the fungi live; therefore, in view of the fact that rubber appears to be an unfavourable medium for the development of these organisms, the possession of proteoclastic enzymes would be of the greatest service in enabling them to open up food reserves not otherwise available. The fact that most of the species of fungi causing spots belong to the genera *Penicillium* or *Aspergillus* is strong evidence for this view. The action of sodium bisulphite as a preventive is probably due to its powers of inhibiting enzyme action. Thus there is much support for the view that the production of enzymes of a specific character by the spot-causing fungi play an important rôle in this problem.

The latest work of Fol and Sohngen is interesting in this respect. These investigators, working in Europe, cultivated two species of *Actinomyces* capable of growing in rubber and investigated their action on the caoutchouc. Viscosity tests with infected rubber showed a decrease when compared with clean, but not sufficient to make any statement as to the inferiority of infected rubber. Attempts to isolate an enzyme failed, though it was noticed in one case that one of the organisms was capable of causing a solution of the caoutchouc.

This work, however, has little bearing upon the problem as it appears in the tropics. The species of bacteria with which Fol and Sohngen conducted their experiments were cultivated from ditch and canal water, and only after several days' incubation did they appear on the caoutchouc. To cause spottings under normal conditions in the rubber factories in the tropics the organisms must germinate quickly and grow vigorously, for thin crêpe rubber is usually dried in twelve days at the outside, and in most cases much quicker than this. Quick germination and vigorous growth are the two essentials in a spot-producing organism, for the period during which moisture can be obtained for growth is very limited.

As regards the quality of spotted rubber, Morgan says that vulcanization experiments prove that it is not inferior to clean rubber. But loss of money and much worry is the lot of the estate manager troubled with spotting, for the presence of spots in the best grades decreases the value so that the rubber is placed in a lower grade and forward contracts can only be met with difficulty.

Attention to the methods of prevention indicated here, and to general cleanliness in preparation, will make light the difficulty caused by spottings.

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# CEARA RUBBER CULTIVATION AND MANUFACTURE IN SOUTHERN INDIA.

By R. D. Anstead, M.A.

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The Ceara rubber tree (*Manihot Glaziovii*) grows like a weed all over the East, but until recently it could not be made to give a large enough yield to be much taken up, though it will grow at higher elevations and under drier conditions than the more popular Hevea rubber. It grows well from 800 to 5,000 ft. altitude, and requires about 50 in. of rain, and it delights in four or five months of dry, hot weather. It is intolerant of heavy wind, but grows very rapidly, making shoots of 18 ft. or more from seed in a single year.

In Southern India this variety of rubber is chiefly cultivated in Coorg, the Mysore State, and the Shevaroy Hills, in the Madras Presidency, on a plantation scale. It was first introduced into Mysore about 1880 as a shade tree for coffee, but it proved unsuitable for this purpose, and was soon cut out. Since then, until comparatively recent years, Ceara has been regarded with a good deal of undeserved contempt as a profitable source of rubber, due to the fact that, owing to wrong methods of manipulation, large numbers of the trees died when they were subjected to tapping. This difficulty has now been overcome, and since 1904 Ceara rubber has been extensively planted, and there now exist some 12,000 acres of it in Coorg, 3,000 acres in Mysore, and 2,000 acres in the Shevaroy Hills.

Most of the experimental work with this variety of rubber with which I have been associated during the last five years has been done in Coorg on the estates of

Messrs. Matheson and Co., with the valuable co-operation of the managers.

Though it grows very easily, Ceara rubber, like other crops, responds to good soil and good cultivation. When first planted in 1904 these points were often neglected, and the trees were often put into the poorest of soils and then left to take care of themselves and struggle with a jungle of grass and weeds, and to this the original failures were largely due. If it is to prove a commercial success it is most important to give the trees a thorough and careful cultivation from the start, and either to keep the clearings clean weeded, or, better still, under a carefully controlled system of leguminous green dressing cover crops, so as to ensure 80 or 90 per cent. of the permanent trees reaching a tappable size at the same time.

The evenness of a clearing is a most important factor in rubber cultivation, because when the tapping stage is reached the majority of the trees in an even clearing can be tapped, making the tasks more easy to arrange for the tappers, and generally facilitating the field arrangements and reducing the cost of production. So important is this factor that it is, in my opinion, better for a clearing to be a year behind in growth but *even*, than for it to make a rapid but uneven growth; and it would probably prove economical to examine clearings annually after they are eighteen months old, and to fork round and manure all backward trees with the idea of making them catch up their better-grown neighbours, and thus produce an even clearing before manuring the clearing as a whole.

It has been customary in Southern India to plant the trees closely at first and afterwards to thin them out. This reduces the cost of weeding, and tends to produce clean, straight stems and high branching. It is probably better, however, to plant the trees at the beginning 15 by 15 ft., and at the end of the third year to take out all those which have been retarded or overshaded by their neighbours.

In any case the thinning out must be done systematically, and the plan adopted is, at the end of the third year to remove all the small, badly grown trees and those which have been broken by wind or damaged by animals or disease. In the following years the smallest trees are again removed, and, after tapping has commenced, all the poor latex yielders, until the requisite number of trees per acre is arrived at, usually 150 to 200. All the trees removed are pulled out by the roots with a jack and burned. This method of thinning finally leaves the permanent trees irregularly spaced, but that does not matter. If a regular system of thinning is adopted by removing every other tree, or every other row, it is bound to happen that some good trees are removed and poor ones left, and no method of selection can be used.

Many of the trees can be tapped when they are 3 to 4 years old, but we have come to the conclusion in Coorg that it is not advisable to start tapping on young trees, and we wait until they are 5 or 6 years old and the bark is fairly thick. As would be expected, the older and more mature the tree the better the yield, and the higher the quality of the rubber obtained. Some of the oldest trees give as much as 2 and 3 lb. of rubber per annum.

In the early days of Ceara rubber great difficulty was experienced with the extraction of latex from the trees. When tapped in the same way as Hevea rubber the bark rotted, and so many of the trees died that the industry proved unprofitable. This difficulty was overcome by using a tapping system in which a separate cut was made at each tapping occasion—a system introduced with success by Mr. Westland in Ceylon in 1909. This system was experimented with and elaborated on estates in Coorg during 1910, and it has proved there the best method of handling young trees.

The system finally adopted after numerous experiments is first to strip the outer bark, which is tough and leathery, off that section of the tree which is to be tapped, usually one-third of the circumference, and then to cut a shallow vertical channel down the centre of this area to act as a conducting channel for the latex to the collecting cup at the base of the tree. Having made this channel, a number of sloping cuts are made with either a Pask V knife, or a knife like that of a farrier, in either case kept very sharp, on the familiar herring-bone system, arranging them in such a manner that they enter the vertical channel alternately on each side. It is important that no two cuts should meet the central channel at the same point so as to form a V with the apex in the central perpendicular channel. As a rule six of these cuts are made, three on each side of the central channel and making an angle of about $22\frac{1}{2}^{\circ}$ with it, the cuts on each side being a foot apart. At the next tapping these cuts are left alone, and in young trees no attempt is made to widen them, but six new cuts are made half-way between the original ones. If paring is attempted it usually meets with failure, as the bark in young trees is so soft that it tears and strips under the knife, and a bad wound is made which refuses to heal, and the death of the tree may result owing to rot and boring insects. On each occasion of tapping, usually in Coorg at intervals of two to four days, six fresh cuts are put in half-way between the old ones, and the spacing can be easily arranged so that it takes at least two years to use up all the bark on the area tapped. When this is done another third section of the tree is stripped of its outer bark and tapped in the same way, so that a four-year bark renewal is obtained.

It is of the utmost importance that the tapping cuts should be made in such a way that the cambium is not wounded, and when this is done the narrow cuts heal up with remarkable rapidity and ease, leaving a clean fresh surface, which can be tapped again. It is of special importance to avoid wounding the cambium in the case of older trees; it is our experience in Southern India that in young trees even bad wounds and cuts made right down to the wood heal up with remarkable rapidity, especially if treated with some antiseptic material, such as coal tar, Jodelite, or lime and sulphur, but that such wounds when made on old trees do not heal readily, and the soft wood inside is apt to decay and result in the death of the trees before the bark can heal over the wound.

Another tapping system which has been used a great deal in Hawaii has been experimented with in Southern

India, and adopted on some of the estates in Coorg in preference to the above. This is the vertical system, in which all the cuts are made vertically down the tree over the tapped area. This system has the advantage of giving a much longer cut, and in some cases it produces an increased yield. The cuts heal rapidly and well if care is taken not to wound the cambium. No figures are available for a strict comparison between the two methods, to which no objection can be raised owing to the variability of yield of individual trees; but in Coorg one large block of Ceara has been tapped on the vertical system, and another near by has been tapped over the same period of time on the herring-bone system, and the results show that there is probably little to choose between the two methods, and, as far as young trees are concerned, it would appear that the choice between the two methods depends largely upon the personal taste of the manager and the ease with which the particular class of labour employed can be taught to use either method.

When we come to deal with old trees—8 years or more—the bark has become sufficiently thick and firm to enable paring to be done, and they can be tapped in a similar way to that adopted for Hevea, the half herring-bone system being usually used with three or four cuts. Here again the vertical system can be, and is, employed, the vertical cuts being easily pared.

By the adoption of these methods, and taking great care not to wound the cambium and to dress at once such wounds if made accidentally, it has been found quite easy to tap large areas of Ceara successfully without loss of trees and to make this industry a paying one.

A few "pricking" methods of tapping have been experimented with, but they were not attended with success under our conditions, and the systems described above, or slight variations of them, have been finally adopted after a large number of experiments, as most suited to our conditions of labour and climate. Some tapping on renewed bark has been done with excellent results.

Whatever system of tapping is employed, the outer bark, which is rough and leathery, must be first removed from the tapping area, and it should be removed from this area only, and not from the whole of the tree, a few days before tapping is begun so as to leave the inner bark smooth and clean and firm.

It is also best to tap in the evening or the very early morning. As the sun gets on to the trees and the temperature rises the latex quickly coagulates in the cuts, and the period of flow and consequent yield is reduced. Again, it is found inadvisable to continue tapping when the trees begin their annual leaf fall or while the leaves are down. Not only is the flow of latex very much reduced during this period, but harm appears to be done to the trees if the latex is drawn from them at this time. Trees tapped during the resting period have a tendency to be later in regaining their full foliage, and the foliage itself is smaller, while bark renewal is decidedly retarded.

During spells of dry, hot weather the flow of latex is apt to become much restricted, and in some districts drip tins containing 1 per cent. ammonia have been used to prevent the rapid coagulation of the latex in the cuts and protract the time of flow. This has met with a certain amount of success, but the length of the tapping season is largely controlled by the climatic conditions, and unless the trees can be tapped for at least four months in the year without the use of ammonia or similar aids, the cultivation would appear to be doubtfully profitable.

As compared with Hevea rubber, the yield even under the best of conditions is small, but more trees can be grown to the acre, and the trees can be brought into bearing sooner. The following are examples of the kind of yield obtained in Mysore from a few trees in the experimental stage with alternate day tapping over a period of three months:—

| Number of trees tapped | Age of trees, years | Average girth at 3 ft. from the ground, inches | Total yield of dry rubber, lb. | Trees per acre | Yield of dry rubber per acre during a three months' tapping season lb. |
|---|---|---|---|---|---|
| 10 | 3½ | 13 | 4½ | 200 | 90 |
| 5 | 5 | 17 | 5 | 200 | 200 |
| 5 | 7 | 26 | 9 | 200 | 360 |
| 2 | 10 | 32 | 4⅜ | 200 | 437 |
| 1 | 15 | 43 | 4 | 200 | 800 |

When we come to results obtained on an estate scale over large areas we get rather similar figures. For instance, in the Shevaroy Hills during 1912 an average of 5,400 three-year-old trees tapped five times at weekly intervals gave a total yield of 142½ lb. of dry rubber, and during a three months' tapping season an average of 5,000 such trees gave a total yield of 3,280 lb. of dry rubber, or a yield of about 130 lb. per acre.

In Coorg 19,260 six-year-old trees, tapped on an average of forty times each, gave 7,486½ lb. of dry rubber, or a little over ⅜ lb. per tree. This represented 170 acres with about 115 tappable trees per acre, but another 40 per cent. per acre have yet to arrive at the tapping stage.

The method of preparation of rubber from the latex is extremely simple. The usual coagulant is acetic acid. As a result of experiments conducted in Coorg, however, it would appear that if a coagulant is used at all, a 6 per cent. solution of formic acid at a temperature of 80° F. gives the best results, producing a rubber which when dry is very elastic and strong.

The system adopted now, however, is not to use any acid or chemical coagulant at all, but to simply allow the latex to coagulate slowly in hot water in a dark room. After coagulation it is rolled and thoroughly washed to remove resins, this rolling and washing being done by machinery. It is then dried in hot air in a dark room, and finally made into sheet or crêpe, as the case may be, in the ordinary way. Some smoked sheet has been prepared and high prices obtained for it, but methods of smoking are at present in an experimental stage.

Ceara rubber contains more resin than Hevea, and it is difficult to remove all of this by washing and rolling without detracting from the physical qualities of the rubber; but as the trees get older this defect will probably largely disappear. In quality, the rubber when made into biscuit or sheet is quite equal to the best plantation Parà, and it commands almost as good a price.

There is much diversity in the yield of trees produced under similar conditions and even growing side by side, and with the object of eliminating this variable factor as far as possible, and at the same time increasing the yield per acre, selection methods are now being adopted in new clearings. By tapping and testing individual trees over large areas, a few which give a very high yield of latex and rubber are selected, and these are broken up into cuttings from which new clearings are planted. The tree grows readily from cuttings if care is taken in planting them. Several clearings have now been established in this way, and it is intended to select the best trees in these and plant further areas with cuttings from them, and it is hoped that in this way the yield per acre may be materially increased in the future. At the same time the possibility of seed selection and the breeding of hybrids with increased latex content has not been lost sight of.

Manurial experiments are in their infancy, and Ceara has not been treated seriously over a long enough period as yet for any reliable figures to have been obtained.

In 1909 Mr. Wilcox, the Special Agent in charge of the Hawaii Experiment Station, published an account of some experiments he had conducted which showed that nitrate of soda had a decided tendency to increase the flow of latex. We repeated his experiments on a small scale with nitrate of soda in 1911, and on a larger scale with nitrate of soda and nitrate of potash in 1912, with the result that Mr. Wilcox's results were confirmed. Nitrate of soda applied just before tapping begins undoubtedly does increase the latex flow and rubber yield of trees which do not normally yield well, while nitrate of potash apparently still further increases this flow. Over areas which normally yield well, however, no improvements could be obtained from the application of these salts. The experiment is still being continued, and perhaps it is too early as yet to say more about the results obtained.

The diseases of Ceara in Southern India are few and comparatively trivial. The most important is a root disease due probably to the fungus *Hymenochæte noxia*, which also attacks Hevea rubber, coffee, tea, and a number of other plants in India. This disease is controlled by removing as many jungle stumps as possible from the clearings and ridding the soil of decaying wood on which the fungus can live, and by means of which it is transmitted through the soil to the living roots. It is for this reason that when thinning operations are in progress all the trees removed are dug out with as many roots as possible. Trees attacked by the disease are dug out as soon as they are noticed, and the soil round them is thoroughly treated with lime.

As a result of the work done on this product during the last five years in South India, the following tentative conclusions have been arrived at:—

(*a*) That Ceara rubber can be successfully grown and tapped at elevations and under climatic conditions which render the cultivation of Hevea rubber unprofitable.

(*b*) That the best planting distance is originally 15 ft. by 15 ft., and subsequent thinning should be done by removing all weak and overshaded trees independently of their position in the rows.

(*c*) That it is advisable to wait until the trees are 5 to 6 years old before beginning to tap them.

(*d*) That the best method of coagulation is with hot water in a dark room; and

(*e*) That given care and good cultivation Ceara rubber will pay. During the last twelve months, with the price of rubber phenomenally low, a profit of 10½d. per lb. was made.

It is not recommended to grow Ceara rubber in preference to Hevea in districts and at low elevations suited to the latter; but in the hill districts, at elevations of 800 to 5,000 ft., with a rainfall of 50 to 80 in., where Hevea will not grow at a profit, there is every reason to believe that Ceara will prove a valuable asset, especially in conjunction with another crop, such as coffee.

## THE CULTIVATION OF MANIHOT GLAZIOVII IN UGANDA.

By Samuel Simpson, B.Sc.

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For more than a dozen years Ceara rubber has been cultivated in Uganda, where it grows exceedingly well, and was being generally planted up to a short time ago. The growth is rapid, the average girth being from 19 to 20 in., and the trees thus ready for tapping, when 3 years old.

On the Government Plantation, Kampala, experimental tapping was carried out last year. The trees, which were 3 years old, were arranged in groups containing twenty each, the average girth of the trees in the various groups varying between 15 and 20 in. The system of tapping was the half herring-bone, paring, and pricking.

The following results were obtained:—

| Number of trees in group | Number of times tapped | Total yield of dry rubber in ounces |
|---|---|---|
| 20 | 10 | 6 |
| 20 | 12 | 6½ |
| 20 | 13 | 7½ |
| 20 | 14 | 10 |
| 20 | 90 | 45 |

These figures show that to get 2¼ oz. of dry rubber per tree no fewer than 90 tappings had to be made, and also that the yield obtained from the trees was in practically direct proportion to the number of tappings.

In July, 1913, eighty trees were taken and tapped on alternate days—forty each day—and the latex allowed to coagulate naturally. The trees had an average girth of 19·78 in., and the average yield of dry rubber per tree was 0·43 oz. after nine tappings.

In August, 1913, forty-tree trees, having an average girth of 19 in., gave a total yield of 19¼ oz. of dry rubber in eleven tappings, or 0·45 oz. per tree.

During October, November, and December, 1913, forty-two trees, with an average girth of 21½ in., were tapped fifty-seven times and gave a total yield of 85 oz. of dry rubber, or an average of 2 oz. per tree.

The above results compare very unfavourably with some already published obtained in the Botanical Gardens, Entebbe; but I understand the Entebbe trees died owing to the severe handling. The Kampala trees are in a thriving condition, and no ill-effects due to the tapping are evident.

With the product at a normal price Ceara rubber just pays a native cultivator at these low yields, but for European planters, with the ever-increasing cost of land and labour, there is nothing left after payment of the essential outgoings, and paying results cannot be looked for unless means are evolved for obtaining more rubber per tree with much less labour.

Ceara rubber is being looked upon on many estates as an excellent training ground for native labour to ensure trained rubber tappers when the Hevea is ready to be dealt with.

Native cultivators have a fair acreage under Ceara because it is very easy to cultivate, whilst the various missions have over 200 acres under this rubber.

European planters have just over 1,000 acres under Ceara, but the tendency is for the area to shrink gradually and more profitable crops to replace it entirely.

Trials have been made with the allied Manihots (*M. dichotoma*, *M. Piauhyensis*, and *M. heptaphylla*), but these are less satisfactory as regards growth than *M. Glaziovii*. The trees are so brittle that they suffer severely from every windstorm. No tapping has yet been done, but I see no reason to hope for any better results in tapping than have been obtained from *M. Glaziovii*.

## AUGMENTATION DU RENDEMENT DU FUNTUMIA ELASTICA AU CONGO BELGE PAR LA METHODE SPARANO.

Par A. Gisseleire.

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La saignée du *Funtumia elastica*, comme d'ailleurs celle de tous les arbres à caoutchouc, a donné naissance à une grande variétés de systèmes, dont la plupart ont été abandonnés. A l'heure actuelle, il est cependant encore difficile de dire avec certitude quel est la meilleure manière de saigner le Funtumia.

Les indigènes abataient les arbres et les incisaient sur toutes les parties capables de donner du latex; après, ce fut le tour à la saignée à coups de machettes sur les arbres conservés, c'était déja un progrès, mais le résultat final de ces deux méthodes primitives fut, indubitablement, la disparition d'une énorme quantité des plus beaux arbres de la forêt.

Des études suivies ont été entreprises par divers spécialistes, afin de déterminer si le Funtumia pouvait être traité de la même manière que l'*Hevea brasiliensis*.

Les résultats furent négatifs parce que la disposition des vaisseaux laticifères diffère essentiellement dans ces deux espèces. Le système de ravivage pratiqué sur le Funtumia conduit inévitablement à la mort des arbres.

Il fallait donc trouver autre chose et les essais furent dirigés dans la voie des incisions peu profondes. L'expérience a démontré que dans le cas où celles-ci sont légères, la cicatrisation se fait rapidement. On saigne donc en arête de poisson (simple ou double) en V ou en spirale, enfin, on a également recommandé le système de saignée par incisions verticales parallèles sur la plus grande partie du tronc. Ici encore, du moment, que les incisions sont peu profondes, la cicatrisation se fait bien, mais si c'est le cas contraire, les lèvres des plaies ne se referment pas, au contraire, elles s'écartent l'une de l'autre et finissent par former, sur le tronc de véritables sillons, qui rendent l'exploitation ultérieure fort difficile. Ce système a l'avantage d'être d'une exécution rapide et facile, mais il faut un nombre considérable de godets pour recueillir le latex. Il en est d'ailleurs de même pour la saignée en spirales.

Le système préconisé par M. le Dr. Christy, qui consiste à tracer sur le tronc, au moyen d'un inciseur spécial, des incisions très peu profondes destinées uniquement à conduire le latex dans les godets. Ceci marque une sérieuse avance sur tous les autres systèmes. La coulée du latex est provoquée, en passant au fond de ces premières incisions, avec une roulette dentée. Ces petites blessures, tout en occasionnant peu de dommage au cambium, suffisent amplement pour assurer une bonne saignée. La cicatrisation de ces plaies est rapide.

Tout en considérant cette méthode comme présentant des avantages réels, elle peut cependant être améliorée, en ce sens, que la saignée qui est pratiquée en un seul jour, peut être répartie sur une semaine et que par suite, il y a moins de risques de rompre l'équilibre dans la croissance de l'arbre.

Cette expérience vient d'être appliquée au Congo par M. Sparano, un des agronomes du district des Bangala.

C'est le système en arête double qui a été appliqué, sur des arbres de 0·55 m. de circonférence. Les grands arbres ont été saignés sur hauteur de 5 mètres. L'arête n'embrasse que la moitié du tronc. L'autre moitié est réservée pour la deuxième saignée, qui est faite après un repos de six mois.

L'arête à été faite de la manière suivante: les incisions de gauche se trouvent à 6 centimètres au dessus des incisions correspondantes de droite et la distance observée entre elles est de 0·24 cent. La saignée est commencée par le bas de l'arbre. Le premier jour on trace 2 incisions, une à droite et une à gauche; le 2e jour repos; le 3e il est pratiqué 3 incisions, le 4e jour repos, le 5e 4 nouvelles incisions, le 6e jour repos, le 7e 5 incisions, le 8e repos et le 9e jour on fait de 6 à 8 incisions.

Les résultats obtenus par ce système sont très encourageants et le rendement est supérieur à celui obtenu par d'autres méthodes.

Un essai effectué à Musa au district des Bangala, sur des arbres de 8 à 9 ans a donné 60·868 kilos de caoutchouc frais, en tenant compte des scraps et en faisant deux saignées par an, le résultat final peut être estimé à environ 200 grammes par arbre et par an.

Un autre essai également fait à Musa, sur 1,696 arbres de 8 à 9 ans a donné 170·568 kilos de caoutchouc frais. En deux saignées le résultat serait sensiblement le même que celui obtenu dans l'essai précédent.

Enfin, un troisième essai exécuté à Kutu, situé près de Musa, sur 1,368 arbres de 8 à 9 ans a donné 157 kilos de caoutchouc frais. Ce résultat est un peu plus élevé que les deux précédents.

Des expériences comparatives entre différentes méthodes de saignées ont été effectuées sur des *Funtumia elastica* au Jardin botanique d'Eala et montrent nettement l'avantage de la méthode Christy modifiée.

| | |
|---|---|
| Par la méthode Schultze (incisions verticales) la moyenne est d'environ ... ... ... ... ... | 50 kilos |
| Méthode Christy ... ... ... ... ... | 100 ,, |
| Méthode Christy modifiée ... ... ... | 150 à 200 ,, |

Soit, 150 à 200, 100, 50 kilos caoutchouc sec par hectare.

La coagulation du latex de *Funtumia elastica*, en le précipitant dans de l'eau bouillante, a donné jusqu'ici le meilleur résultat. Dès que le latex vient en contact avec l'eau en ebullition le coagulum se forme en masses floconneuses et vient flotter à la surface. Il suffit de l'enlever et de passer la masse dans une presse. Le caoutchouc ainsi obtenu est lavé à grande eau et séché. Il est de très bonne qualité, nerveux et évalué de 6 à 6·10 fr. le kilo, alors que le caoutchouc d'Hevea de plantation était côte à 6·50 fr. le kilo.

# THE METHODS OF TAPPING CULTIVATED CASTILLOA TREES, AND THE YIELD OF RUBBER THEREFROM.

By Professor P. CARMODY, F.I.C., F.C.S.
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THE method most in favour in Trinidad and Tobago for the tapping of Castilloa trees requires no lengthy description. The implements used are a chisel with a specially thin cutting edge about 1½ in. wide, and a wooden mallet. Every other method has been tried, including paring and puncturing.

Cuts are made along the trunk about 12 in. apart vertically. Another series of cuts at about 4 in. to the right and left are made, and these are continued right round or half round the tree as high as can be reached on foot or on ladders. The cuts are made as shown in the diagram.

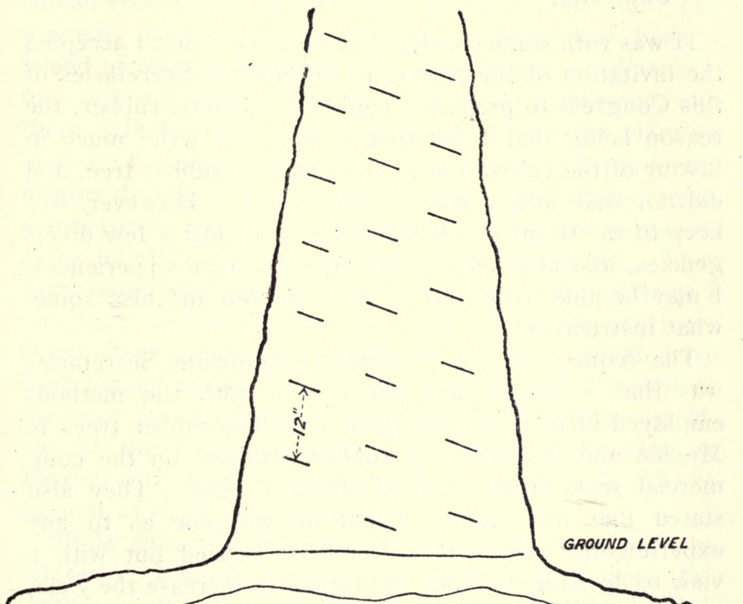
The chisel is pointed slightly upwards, so that the bark on the upper edge of the cut may protrude slightly over the lower edge and prevent the entrance of rain. Clean cuts should be made, and each cut should slope slightly downwards from the horizontal to facilitate the collection of the latex. The proper depth of the cut is easily ascertained after a short experience.

It depends on the condition of the trees, and the length of the intervals between the tappings, whether the latex will flow from or coagulate on the cuts. If it coagulates on the cuts, the best course is to make a ball of the rubber direct from the tree, stretching the rubber as much as its strength will allow. This stretching appears to improve the rubber.

The latex when plentiful may be collected in cups or in any other convenient receptacles, and the rubber immediately separated from it in a centrifugal machine, or more slowly by creaming and setting in shallow trays with porous cloth bottoms. Coagulation may be hastened by the addition of dilute acetic or sulphuric acid, or an aqueous extract of the "moon" vine (*Ipomœa bona-nox*).

In Trinidad and Tobago Castilloa has not been grown as a separate cultivation. It was recommended some thirty years ago as a shade tree for cacao, and it has been tried for that purpose only over small areas. Under these

DIAGRAM SHOWING METHOD OF TAPPING CASTILLOA TREES.




conditions it has not given, and could not be expected to give, the best results; and the yield of rubber from our trees may be considerably less than that from trees grown under different conditions. The best results that have been obtained in Tobago from young trees tapped for the first time to a height of 20 ft. for half the girth of the tree are for an average of 10 trees 10·8 oz., and for 288 trees a little over 5 oz. for a single tapping, and 3·4 oz. for a second tapping four months later.

## THE METHODS OF TAPPING CASTILLOA RUBBER TREES IN MEXICO, AND THE YIELD OF RUBBER WHICH THE TREES FURNISH.

By Ashmore Russan.

*Director of the Soconusco Rubber Plantations, Ltd.; London Director of the La Zacualpa Plantation Company.*

It was with some considerable hesitation that I accepted the invitation of the Honorary Organizing Secretaries of this Congress to prepare a paper on Castilloa rubber, the reason being that I felt that I could not write much in favour of the cultivation of the Castilloa rubber tree, and did not wish in any way to disparage it. However, if I keep to the terms of the reference, with just a few divergencies, and also keep to my own personal experiences, I may be able to be just to the Castilloa and also somewhat instructive.

The request of the Honorary Organizing Secretaries was that I should deal particularly with the methods employed in tapping plantation Castilloa rubber trees in Mexico and the yields of rubber obtained on the commercial scale from trees of different ages. They also stated that information would be welcome as to any experimental work which has been carried out with a view to devising methods of tapping to increase the yield, and also as to the differences in the yield of rubber from the different varieties (or species) of Castilloa which occur in Mexico.

That is the reference, and I propose in the main to confine myself to it.

By way of preface I should say that I made the acquaintance of the Castilloa rubber tree in Mexico in the year 1900, when I visited, amongst other plantations, those of La Zacualpa, in the Soconusco District of the State of Chiapas. In the La Zacualpa plantations I have been interested ever since that date, and with regard to another estate, almost adjoining, I have for some four years been a director of the British company owning it.

The La Zacualpa Estates, now comprising over 12,500 acres of cultivated Castilloa rubber, are owned by two American companies, with headquarters at San Francisco.

In 1900 the cultivation on a considerable scale of Castilloa rubber on the La Zacualpa Estates had just been commenced. I should remark, however, that there were at that time a few thousands of cultivated Castilloa rubber trees reported to be from 12 to 14 years old. The previous Mexican owner of the property had been a friend of Matias Romero, once Ambassador at Washington, and the father of rubber cultivation in Mexico, and there is little doubt that Romero suggested the planting of those few thousand trees. They had been tapped very frequently before 1900, and they have been tapped twice a year (if not more often) ever since. They are now from 27 to 29 years old; their exact age is not known. They were fairly well planted, about 18 ft. by 12 ft., so far as I recollect. A few of them have died. I saw the survivors about three years ago, and those survivors, which have been tapped regularly for about twenty years, constitute the most favourable evidence as to the continuous yielding of the Castilloa rubber tree under cultivation in Mexico with which I am acquainted. I will deal with the amount of their yield presently.

While thus diverging from the strict terms of the reference, I would like to say that before visiting the estates in question I paid a visit to a Castilloa rubber plantation in the Mexican State of Oaxaca which had been honoured by mention in a British Foreign Office paper. I am afraid that paper, written and issued in all good faith, cost British and other investors a great deal of money; it certainly is a striking example of the unwisdom of accepting evidence at second hand. The plantation, the famous, or notorious, Esmeralda, one of the earliest planted in Mexico, owed its notoriety to that Foreign Office paper. I found in 1900 some 40,000 Castilloa trees 8 to 10 years old, very well planted in straight rows, at a fairly good distance apart for that time (some 12 ft. by 12 ft.), and some 50,000 younger trees. The older trees had been frequently tapped, but I failed to find any record of rubber sold, and there were no samples at the Hacienda. The evidence of tapping was in plenty. The trees had been heavily scored with machetes. I tried perhaps a score of them. There was no latex, so I had holes dug in the ground in the endeavour to find out what was the matter. At from 2 to 3 ft. from the surface I found a sort of conglomerate of limestone, practically a concrete; the manager called it "hard-pan." It had resisted the tap roots, which were curled up towards the surface. Those trees, which had a fairly thriving appearance, have never yielded any rubber to speak of, and never can. I mention them as an example of the sort of land on which not to plant Castilloa rubber.

### *Methods employed in Tapping Plantation Castilloa Rubber Trees in Mexico.*

Previously to 1903 the only tapping tool employed was the machete, a kind of sword or sabre, with a blade about 3 ft. long, used for all kinds of agricultural purposes, such as chopping down trees, clearing undergrowth, making hillocks and holes for planting rubber seeds and seedlings, and for purposes of offence, as killing snakes, and, incidentally, men. A really sharp machete was, and is, rather a rarity, consequently the result of tapping Castilloa rubber trees with it was murderous. Great gashes were inflicted—anywhere, at all angles, anyhow. The deeper the cut the more latex—or so the Indian tapper appeared to think—and in consequence there are now practically no wild Castilloa rubber trees of tappable size to be found in Mexico, except perhaps in some dense and almost impenetrable forest. One would think that the murderous machete would never be used in plantations, but in 1900 and later it was the only tapping tool employed on all the estates I have mentioned, and on two or more of the estates the older trees are suffering now from its use. As to Esmeralda, it would have made little difference if the trees had been tapped with woodmen's axes.

The Castilloas there, if any are still alive, merely cumber the ground.

Some ten years ago a tapping knife was evolved, I believe, on the La Zacualpa Estate which is still in use. There are varieties and perhaps improvements, but all are much alike, and the principle of all is the same. The depth of the cut can be regulated from about $\frac{1}{8}$ in. upwards; the width of the cut is about $\frac{1}{2}$ in. I have personally tried almost all kinds of tapping knives on Castilloa rubber trees, but only one, in addition to the knife now referred to, was of any utility. The exception I refer to was an exhibit at the Rubber Exhibition held at the Agricultural Hall. The name of the inventor or originator has escaped me, but he came from Mexico, and I tried his knife on some Castilloa rubber trees at that Exhibition. It may be remembered as having a handle like that of a saw and as running on wheels. It did the work, but was not nearly so simple and effective as the knife which is in use to-day on the largest estates in Mexico. The latter is rather a murderous-looking implement, but it must be remembered that the delicate tools used for tapping Heveas are of no use whatever for tapping Castilloas, the reason, I understand, being that the latex cells of the Castilloa are long and vertical, one transverse sloping cut completely draining some 4 to 6 or more inches above it, while the Hevea latex cells are more like a honeycomb, in which the slightest paring of the bark should open up fresh cells. All Hevea tapping tools that I have ever seen are useless for Castilloa. I have tried triangle-shaped tools which would cut sufficiently deep, but the waste bark choked them up at once. Any Castilloa tool must have a free vent, with the cutting edges of the blade nearly $\frac{1}{2}$ in. apart. It must also have an extra blade for opening the cuts. Such a knife makes a great gash in the tree nearly as wide as one's finger, but that would appear to be necessary, as Castilloa latex at certain times of the year will not flow readily, and has to be wiped out of the cut with the forefinger of the tapper. The depth of the cut can be regulated according to the age of the tree and consequent thickness of the bark, and this matter should be carefully attended to by the foreman or "caporal" of the tappers before starting out; but the Mexican Indian tapper is both independent and insubordinate, and no doubt often cuts a young thin-barked tree just as deeply as he would an older thicker-barked one. I have seen prickers and hammer-chisels used for tapping Castilloas, but they were not effective, and, so far as I know, the knife described, or others on the same principle, has not been improved upon, and is not likely to be.

*The Yields of Rubber obtained on the Commercial Scale from Trees of Different Ages.*

To me this question is a delicate matter. In the London *India-Rubber Journal* (Quarter Century Number), issued in 1909, a scale of yields was published in an article under my name. I give it here, with apologies, only pleading that my experience then was not so thorough as it is now; it also related to Castilloas in the Soconusco District of the State of Chiapas, and was as follows:—

"For 6-year-old trees, ½ lb. per annum; for 7 years, ¾ lb.; for 8 years, 1 lb.; for 9 years, 1¼ lb.; for 10 years, 1½ lb.; for 11 years, 1¾ lb.; for 12 years, 2 lb."

As I shall show presently those figures were unduly optimistic. But they had what appeared to me to be a sound basis—the published yield of certain wild trees. In April, 1898, Sir Daniel Morris delivered a Cantor Lecture, in which he dealt very ably with the Castilloa rubber tree in many countries. With regard to the yield in British Honduras he was very cautious. I quote from the published lecture: "A large tree of Castilloa, say 2 ft. in diameter, is said [is *said*, please note that] to yield 8 gallons of milk when first cut. Each gallon of milk in the proper season will make about 2 lb. of rubber. Hence a tree of this size will give a return of 16 lb. of rubber."

Now as to those 16 lb. from one wild tree, I have to say that I have had credible information as to wild Castilloa rubber trees which have yielded more than twice as much. I have heard, credibly, of 50 lb. from an old Castilloa at one tapping, which, however, probably extended over a week and ended in the death of the tree, which, indeed, might have been felled at the start to facilitate the extraction of the latex.

But all such trees were huge, old forest trees which had never before been tapped and, when discovered, were drained utterly. Such trees must have grown under very favourable conditions. The nearest Castilloa rubber tree of size might have been 100 yds. or a mile distant. There are few, if any, of such large wild trees left anywhere. But with certain and confirmed knowledge of such yields, it must appear quite reasonable to estimate (until the contrary was proved) that a 6-year-old cultivated tree in a plantation would yield ½ lb. of rubber per annum, and a 12-year-old tree 2 lb.

But to those who have cultivated Castilloas, the mere mention of such yields as I have mentioned from wild trees, however *bona fide*, must be in the nature of an insult to their intelligence, so I will get back to the proved yield of the Castilloa in cultivation in the most favourable district I am acquainted with, the before-mentioned District of Soconusco in the State of Chiapas. On one estate with which I am very well acquainted the trees range from about 2 years old to about 14 years. No trees under 6 years old are tapped, unless they are being cut out. The trees are tapped twice a year, and the average yield of all ages per tree per annum in dry rubber is a fraction under 4 oz.

The average yield of trees of various ages may be roughly allocated as follows: 6-year-old trees, 2 oz. of dry rubber; 8 years old, 3 oz.; 10 years old, 4 oz.; over 10 years old (if not under shade or dwarfed from having been under shade, or from too close planting), 6 to 10 oz. The average of some 250,000 trees (all too closely planted and some still under shade) which are now being tapped twice a year is, as I have said, a little under 4 oz. per tree. It has been shown by some two years of experiments that the trees yield as much in two tappings per annum as in four or more. The saving in bark waste with two tappings only per annum will be appreciated, considering the width of each cut.

From trees 12 to 14 years old which have been dwarfed by too close planting or from failure to cut out the original shade, more than 4 oz. per annum can scarcely be expected. It must be remembered that on all South Mexican estates the trees were originally planted 400 to the acre, and the only way of improving the yield is to thin them out. Had the trees been planted on properly cleared land 20 ft. by 20 ft., or 109 to the acre, their averâge yield would no doubt have been much greater.

I will now return to the old cultivated Castilloas on La Zacualpa, now 27 to 29 years old. They have for some years yielded an average of 2 lb. of dry rubber per annum, and are expected to continue doing so. But they were originally planted fairly wide apart, and now, owing to cutting out where too close, and to a few deaths, they stand at about the proper distance from each other.

I should add that the soil of the estates in question is excellent, mostly dark alluvial, frequently 20 ft. in depth, with occasional areas of light sandy soil. The rainfall is about 100 in., seven months rainy season and five months dry. February, March, April, and May are often very dry. In the same locality there are a few other Castilloa plantations with fairly good prospects, but in the other States of Mexico nearly every Castilloa plantation—and there are many—has been abandoned, or the land turned to other uses. I would not like to suggest how many millions of dollars have been lost in Mexico by inexperienced Americans through planting Castilloas on unsuitable land, but they have been many. The Castilloa is so deceptive. Up to 3 or 4 years old the trees almost invariably look splendid; then the tap root strikes the hard-pan, or the rock, or something else, or a Norther strikes the trees, and they die off.

The yield of the Castilloa rubber tree compared with that of Hevea must seem ridiculous, say 4 oz. compared with from 2 to 4 lb. Yet the Castilloa has its points. The actual cost of tapping the trees twice a year is infinitesimal compared with the cost of tapping Heveas from 100 to 200 times a year. There are in Mexico two or three young Hevea plantations, and it is now pretty certain that Para rubber trees will thrive there and yield well. But will labour be available to tap them? I have grave doubts whether the Mexican Indian is capable of the delicate work required for tapping Heveas, or if sufficient men can be obtained. That is the great trouble with Castilloa cultivation in Mexico—insufficient and very inferior labour. If the women and girls could be employed the tapping of Heveas might be done; but they will not, or cannot, tap Castilloas, which, owing to the original close planting, require 16-ft. ladders.

*Experimental Work carried out with a view to devising Methods of Tapping to increase the Yield.*

Scores of experiments have been made with that object in view, but the yield could only be increased by putting more cuts on the trees. Ladders were lengthened from 12 to 16 ft., which would enable the tapper to reach up to some 20 ft., the lowest cut being close to the roots. Trees have been experimentally tapped monthly, six times a year, and four times a year, but, as I have said, they yielded no more than with two tappings per annum. I am now satisfied that the yield can only be increased by fostering the growth of the trees, by thinning out to increase their leaf area, by forking, manuring, and mulching—that is, by cultivation. Spindly trees have been pollarded, the result being fairly satisfactory. The growth of other trees in measured areas is watched carefully, monthly measurements being taken and reported. The result of forking and manuring these measured trees has been most satisfactory, but the idea of increasing the yield by new methods of tapping has been quite abandoned. The maximum yield I look for is that of the old cultivated trees at La Zacualpa, 2 lb. per tree, and this can only be attained by painstaking cultivation.

*The Yield of Rubber from the different Varieties (or Species) of Castilloa which occur in Mexico.*

I must say at once that I am not a botanist, and I have only noted two different species of Castilloa in Mexico. An eminent Washington botanist gave the Castilloas of Soconusco (the district with which I am dealing) a distinct name, *Castilla* (*Castilloa*) *lactiflua*, but in my opinion the difference, except in one instance which I will mention, is wholly a matter of environment. Seeds of the so-called *C. lactiflua* from Soconusco have been sown on the Isthmus of Tehuantepec; the resulting trees scarcely yielded any latex at all; it certainly did not flow, but had to be brushed out of the cuts. A number of abandoned plantations in other parts of Mexico were planted with Soconusco Castilloas—*C. lactiflua*, if you will. Result: they are abandoned. I have tapped trees at, say, 2,000 ft. altitude in Soconusco, not more than five miles from La Zacualpa. They ought to have been *C. lactiflua*, but there was scarcely any latex. A little froth oozed into the cuts, but it was not fluid. Managers of Castilloa estates in other parts of Mexico, where the cultivation had been a dead failure, have visited Soconusco, and have examined the trees. So far as I know none of them ever saw any difference botanically or in appearance, so I can only give my opinion for what it is worth, viz., that with one exception the only difference is in the environment—soil, rainfall, climate, freedom from Northers, etc.

There are, however, some trees on every Castilloa plantation which the tappers pass by. They call them "Húle Macho." Húle is the Spanish word for the Castilloa rubber tree. Macho is a he-mule. My attention has been called to a few of these trees, which never, I believe, yield latex. They are easily recognizable. The bark is of a reddish-brown colour and often hairy, but there are very few of them. They may be a different species, perhaps allied to the "Toonu" of Nicaragua and Costa Rica, but by "Húle Macho" the Indian tapper either means a male Castilloa or a mule Castilloa—a cross. I am not aware that they flower and seed, or that any botanist has studied them. Be that as it may, the "Húle Macho" is the only species of Castilloa in Mexico different from *C. elastica* that I am acquainted with.

## KAUTSCHUK-ANBAU IN DEN DEUTSCHEN KOLONIEN.

Von Dr. Fritz Frank.

*Kautschuk-Zentrastelle für die Kolonien, Berlin.*

Bei der grossen Ausdehnung der deutschen Schutzgebiete ist jede Frage des Anbaues von technisch verwendbaren Nutzpflanzen von grosser Bedeutung. Es ist nun leider die Lage so, dass die deutschen Schutzgebiete denen anderer Nationen gegenüber insofern ungünstiger stehen, als dort sowohl die Bodenverhältnisse wie die Witterungsverhältnisse und nicht zum mindesten die Verkehrsverhältnisse ungünstig oder nur zum Teil günstig sind. Man hat mit grossen Fleiss und grosser Energie versucht, dem Boden unter den örtlichen Verhältnissen das abzuringen, was er hergeben kann. Eines der Produkte, welches in grösserem Masstabe angebaut wurde, und welches zu Anfang auch einen gewissen guten Gewinn in Aussicht stellte, ist der Kautschukbaum. Der Erfolg wäre selbst unter den heutigen ausserordentlich ungünstigen Marktverhältnissen, welche naturgemäss durch die grossen Ernten in den englischen und holländischen Plantagen herbeigeführt werden mussten, noch erträglich und jedenfalls erträglicher, wie er es heute ist, wenn man mehr von allen interessierten Stellen aus den Verhältnissen Rechnung getragen hätte. Die Reichsstellen hätten wohl manches im technischen Interesse der Kautschukgewinnung und Aufbereitung besser und entschiedener beeinflussen können, wenn mehr Mittel zur Verfügung gewesen wären und mehr wirkliche Techniker zur Bearbeitung der Frage herangezogen worden wären, und wenn endlich die Arbeiterfrage in güngstigerer Weise sich hätte lösen lassen. Ob und inwieweit dieses letztere möglich ist, kann hier nicht entschieden und behandelt werden. In den Anschauungen hierüber stehen sich die Verwaltung und die Pflanzer direkt widersprechend gegenüber. Aber auch die Pflanzer selbst haben wohl, durch die scheinbare Gunst der Verhältnisse verleitet, manchen Fehler gemacht, der heute schwer wieder gut zu machen ist. Trotz alledem wird aber doch die mit nicht zu grossen Verwaltungsspesen belastete Pflanzung auch jetzt noch einen gewissen Gewinn dem energischen Bearbeiter lassen, zumal viele Fragen der Bearbeitung der Produkte selbst inzwischen einwandsfrei aufgeklärt wurden.

Eine der allerwichtigsten Fragen zur Sache ist neben den erwähnten der Verwaltung und der Arbeiter diejenige des Anbaues der geeigneten Bäume. Man hat sich zuerst von dem Gesichtspunkte leiten lassen, dass Anpassungen von Bäumen, welche unter ganz anderen Verhältnissen in der Wildnis gedeihen, nicht erwartet werden konnten. Diese Anschauung ist, wie besonders die Arbeiten, die in dem Kongostaat durchgeführt sind, beweisen, nicht völlig zutreffend. Es gelingt durchaus, Anpassung in weitgehendem Masse auch unter ganz anderen Witterungsverhältnissen zu erzielen. In den Versuchsgärten des Kongostaates blieben zunächst die Heveen gänzlich zurück und man hatte schon angenommen, dass dieselben nicht entwickelungsfähig wären. Ein Teil der Anpflanzungen wurde daher direkt vernachlässigt. Als 1912 dann diese Pflanzungen von dem Direktor des Agrikultur Departements wieder ausgesucht und eingehend untersucht wurden, hatte es sich gezeigt, dass auch in Gegenden, welche unter 2,000 mm. Regenfall haben, die Heveen sich anpassen konnten und sich zu normalen Milchgebern entwikkelt hatten. Man konnte von 8 bis 10 jährigen Bäumen, die allerdings im Umfange den Massen nachstanden, welche man bei gleichaltrigen Bäumen in Singapore und Malaya erzielt, doch immerhin Milcherträge bei normaler Zapfung erhalten, welche einem Jahresertrage von 360 bis 800 gr. trockenem Kautschuk gleichkamen. Die sorgfältigen Beobachtungen, welche an der Goldküste von Tudhop ausgeführt wurden, hatten inzwischen schon die gleich günstigen, ja zum Teil noch weit überragende Resultate ergeben, allerdings unter etwas günstigeren Niederschlagsverhältnissen.

Auch in Kamerun hat sich inzwischen die Hevea ansiedeln lassen und liefert eine, wenn auch nicht übermässige, so doch befriedigende Jahresausbeute an gutem und erstklassigem Kautschuk. In Ostafrika ist man mit dem Heveen-Anbau nur sehr langsam vorangegangen. Der Kautschuk, der von einigen Versuchsbäumen geliefert wird, lässt je doch erwarten, dass sich auch hier die Heveen an einigen Stellen wenigstens ansiedeln lassen würden. Leider ist ein grosser Anbauversuch dadurch in seinen Entwicklungen gänzlich behindert worden, weil die Sumatra-Stumps auf dem Transporte in Afrika selbst unsachlich behandelt worden sind.

Nachdem ich über die Anpassungs-Möglichkeit gesprochen habe, mag es noch wichtig erscheinen, mit wenig Worten auf die Bodenverhältnisse, welche die Anpassungsmöglichkeit ergeben, einzugehen. Der Boden, welcher ganz allgemein vom Kautschuk bevorzugt und verlangt wird, ist in allen Fällen ein tiefgründiger und lockerer. Eine gute Feinheit wird verlangt, dagegen wird nicht so sehr ein besonderer Humus-Reichtum beansprucht. In anderen Kolonial-Ländern hat man mit der Düngung und besonders mit der künstlichen Düngung auch erst spät begonnen, ausgehend von der Anschaung, dass bei dem grossen Ländereibesitz eine volle Ausnutzung des Bodens nichts schaden würde. Man hat dabei immer die günstigen Marktpreise im Auge gehabt, welche sehr bald eine volle Amortisation der Anlage in Aussicht stellten.

Die naturgemäss eingetretenen Verhältnisse haben nun aber doch gezeigt, dass man sehr viel rationeller arbeiten muss. Es ist daher doch ernstlicher an die bessere Bodenausnutzung und bessere Pflanzenentwicklung durch Düngungsversuche gegangen. Merkwürdig ist es, dass so wenig greifbare Ergebnisse über die Düngungen vorliegen. Trotzdem kann man aber doch schon mit absoluter Sicherheit sagen, dass eine rationelle Kunstdüngung Erfolg gibt. Der Erfolg ist in erster Linie in der quantitativen grösseren Ausbeute der Bäume zu finden. Nicht dagegen hat es sich bisher erweisen lassen, dass auch die Qualität durch die Düngung beeinflusst wird. Die Kautschukzentralstelle hat gleichfalls neben den Versuchen, die die Kolonial-Regierung Deutschlands in sehr wichtigem Masstabe ausführt, selbst Versuchsdüngungen unter Kontrolle und ist dabei vom Kali Syndikat in liebenswürdigem Entgegenkommen unterstützt worden. Es kann, soweit die Ergebnisse sich heute übersehen lassen, mit guter Sicherheit auch aus diesen Versuchen das quantitativ günstige Ergebnis bestätigt werden. Ueber die Ergebnisse aus den Versuchsfeldern ist in dem letzten Jahresbericht der Zentralstelle berichtet worden.

Angebaut worden sind in Ostafrika in erster Linie Manihotbäume und an einzelnen wenigen Stellen Lianen und nur ganz vereinzelt, wie dies bereits oben angedeutet wurde, an einzelnen Stellen einige Heveabäume. Ihre Zahl ist in den Statistiken wegen der Geringfügigkeit noch nicht verzeichnet. Sie finden sich in dem Bericht über die deutschen Schutzgebiete 1912-13 unter der Gruppe "Verschiedenes." In Westafrika ist im geringen Umfange Ficus, in der Hauptsache Kickxia, im geringen Masstabe Manihot, einiges an Lianen und immerhin bereits über 1 Million an Heveabäumen angepflanzt worden. Die Anpflanzungen in Togo beschränken sich auf ein kleines Landstück Hevea, auf etwas mehr an Manihot, 11 Hektar Ficus und 25 Hektar Kickxia. Dasxunter schöner Bewirtschaftung stehende Neuguinea hat einen verhältnismässig guten Bestand an fast allen Kautschuk liefernden Bäumen mit Ausnahme von Lianen. Man hat hier sehr viel Zwischenkultur und zwar sowohl Kakao wie Kokospalmen angepflanzt und ist in einzelnen Beständen direkt wegen der ungünstigen Lage und wohl zum Teil auch mit wegen der Schwierigkeit der Arbeiterbeschaffung an das Totzapfen einiger Bestände gegangen, zum mindesten hat man sich damit beschäftigt, durch Totzapfen einen Teil der Bestände in einem erheblichen Masse auszulichten. Samoa hat, wenn auch im kleinen Umfange guten Bestand an den verschiedenen Bauarten. Im Nachstehenden soll tabellarisch eine Uebersicht über den Bestand nach dem letzten statistischen Nachweis gegeben werden:—

| | Deutsch-Ostafrika | | Kamerun | | | Togo | | |
|---|---|---|---|---|---|---|---|---|
| | Bebaute Fläche | | Bebaute Fläche | | Bäume | Bebaute Fläche | | Bäume |
| | insges. | ertragsfähig | insges. | ertragsfähig | insges. | insges. | ertragsfähig | insges. |
| | *ha* | *ha* | *ha* | *ha* | *Stück* | *ha* | *ha* | *Stück* |
| *Kautschuk*:— | | | | | | | | |
| Ficus ... ... | — | — | 43 | 8 | 17659 | 11 | — | — |
| Kickxia ... ... | — | — | 3588 | 996 | 4696909 | 25 | — | — |
| Manihot ... ... | 44903 | 17044 | 175 | 29 | 116721 | 137 | 20 | — |
| Lianen ... ... | — | — | — | — | 20350 | — | — | — |
| Hevea ... ... | — | — | 3589 | — | 1143803 | 1 | — | 700 |
| Castilloa ... ... | — | — | 7 | 1 | 2584 | — | — | — |
| Verschiedenes ... | 414 | 72 | — | — | — | — | — | — |

*Schutzgebiete der Südsee.*

| | Neuguinea mit Inselgebiet | | | | Samoa | | | |
|---|---|---|---|---|---|---|---|---|
| | Bebaute Fläche | | Bäume | | Bebaute Fläche | | Bäume | |
| | insges. | ertragsfähig | insges. | ertragsfähig | insges. | ertragsfähig | insges. | ertragsfähig |
| | *ha* | *ha* | *Stück* | *Stück* | *ha* | *ha* | *Stück* | *Stück* |
| *Kautschuk*:— | | | | | | | | |
| Ficus ... ... | 1597 | 937 | 297994 | 170138 | 20 | — | 8871 | — |
| Kickxia ... | 12 | — | 5399 | 12 | 5 | — | 7600 | — |
| Manihot ... | 1 | — | 30 | — | — | — | 8185 | 85 |
| Lianen ... | — | — | — | — | — | — | — | — |
| Hevea ... | 463 | 20 | 205310 | 7646 | 1086·4 | 205·3 | 413511 | 71785 |
| Castilloa ... | 266 | 242 | 78811 | 39960 | 50·5 | 10·5 | 50353 | 3257 |
| Verschiedenes ... | — | — | — | — | — | — | — | — |

Der Ertrag, welcher in den verschiedenen Schutzgebieten aus den Kautschukbäumen gewonnen wird, ist verschieden. Er ist aber für die einzelnen Baumarten doch ziemlich normal. Am ungüngstigsten in der Ertragsfähigkeit ist noch immer der Manihotbaum Ostafrikas und es ist nicht ganz sicher, ob nicht bei der ersten Saateinfuhr eine etwas ungünstige Sorte zufällig zum Anbau gekommen ist, da in anderen kolonialen Ländern günstigere Erträge erzielt werden. Besonders wird von günstigen Erträgen aus holländischen Besitzungen, aus Ceylon und von den französischen Anpflanzungen in Brasilien berichtet.

Ueber die Kautschukpreise zu sprechen, erscheint hier nicht angängig. Sie sind genügend bekannt und genügend deprimierend für die derzeitige Lage. Dass sie aber immerhin, wenigstens in einer Anzahl von Fällen, Nutzen lassen, ist bereits oben gesagt.

Eine andere Frage, welche aber an dieser Stelle behandelt werden muss, ist die der Anbauart und es muss mit aller Entschiedenheit wieder und wieder betont werden, dass ein zu enges Pflanzen nicht nur für die Baumentwicklung ungünstig ist, sondern auch eben bei der geringeren Stammentwickelung ungünstigere Erträge naturgemäss geben muss. Die Anschauungen, als ob eine enge Pflanzweite bei grosser Baumzahl reichere Erträge gibt, ist nur für die allerersten Jahre vielleicht zutreffend, für später ist sie in jedem Falls ein Trugschluss. Nur der gut entwickelte Stamm mit gutem Blattdach gibt dauernd guten und relativ reichen Ertrag. Im Kreuzverband 5 zu 5 m. gepflanzt sollte eine Pflanzweise sein, die nicht unterschritten werden soll. Es ist in vielen Fällen sogar günstiger, noch weiter zu pflanzen.

Ein unbedingtes Erfordernis ist es weiter, die Pflanzung gut rein zu halten. Eine Zwischenkultur ist nur mit Vorsicht zu geniessen, und hat oftmals nicht viel positiven Erfolg ergeben.

Hier mag nochmal auf den Wert der Düngung deswegen zurückgegriffen werden, weil zweifellos solche Düngungen, welche den Stickstoffgehalt im Latex vermehren, von Bedeutung für das endgültig erhaltene Produkt sein müssen, und, wenn nach dieser Richtung hin Erfolge noch nicht zuverlässig vorliegen, so mag dies zum Teil mit darauf zurückzuführen sein, weil es bis vor kurzem nicht recht gelingen wollte, die Stickstoffsubstanzen aus der Milch in zuverlässiger Form mit abzuscheiden. Neuerdings scheint es, als ob nach dieser Richtung hin sich doch ein Wandel schaffen lässt. Es gibt schon jetzt Verfahren zur Kautschukabschiedung aus der Milch, durch welche die stickstoffhaltigen Eiweiss-Substanzen in ziemlich unzersetzlicher Form beim Kautschuk erhalten bleiben; es mag nur beiläufig auf das nicht nur teoretisch, sondern auch technisch zu dieser Frage wichtige Colloseus-Verfahren hingedeutet werden.

Nach all dem vorher Dargestellten bleibt nur noch übrig, auf die Frage der bebauungsfähigen Fläche, welche in den Schutzgebieten zur Verfügung steht und auf die Anzahl der arbeitsfähigen Bevölkerung hinzuweisen, da ganz besonders die Arbeiterfrage von ausschlaggebender Bedeutung für die Tropenwirtschaft ist. Die Gesamtfläche der Schutzgebiete umfasst ca. 3 Millionen Quadratkilometer, die Anzahl der in den Farmbetrieben insgesamt beschäftigten Arbeiter beträgt run 111,000. Die Lohnverhältnisse sind nicht nur in den einzelnen Schutzgebieten untereinander, sondern leider auch, besonders in dem ostafrikanischen Schutzgebiet schon in benachbarten Gebieten sehr verschieden. Leider ist bei diesem Referat nicht der Raum, auf all diese wichtigen Einzelheiten einzugehen. Es mag nur noch betont werden, dass noch viel Land zur Verfügung steht, und dass es nicht angängig ist, für ein Kolonialamt, sich allzu stark auf e i n e Kulturat zu werfen. Hierfür ist gerade der Kautschuk-Plantagenbau eines der markantesten Beispiele.

Es gibt noch manches Andere, was sich ausser dem bisher schon bevorzugten Kolonial-Produkten, wie Fettprodukten, Kautschuk, Kakao, Baumwolle, Fasermaterial, Kaffee, Tabak und Tee anbauen lässt und es wird die Arbeit der nächsten Jahre sein, hier für die einzelnen Landgebiete die richtige Auswahl zu treffen und die richtige Zusammensetzung des plantagenmässigen Betriebes für die einzelnen Bezirke festzustellen. In mancher Beziehung würde sich Deutschland wohl noch, besonders auch durch Futter und Nahrungsmittel-Anbau in den eigenen Kolonien von den Erzeugnissen fremder Kolonien unabhängig machen können. Wir unsererseits sind gern bereit, in all diesen Fragen weiter mit zu arbeiten und hoffen, dass es dem festen Zusammenarbeiten der Kolonialregierung und der Pflanzer und Pflanzungs-Unternehmer gemeinschaftlich mit den deutschen Technikern gelingt, dieses erstrebenswerte Ziel der rationellen Ausnutzung der Schutzgebiete nicht nur im Interesse der bodenständigen Bevölkerung, sondern auch der ganzen deutschen Wirtschaftslage zu erreichen.

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# NECÉSSITÉ POUR L'INDUSTRIE DU CAOUTCHOUC DE LA DÉTERMINATION PRÉCISE AU LABORATOIRE DE LA VALEUR RESPECTIVE DES CAOUTCHOUCS.

Par M. LAMY-TORRILHON.

*Président de la Chambre Syndicale des Fabricants de Caoutchouc.*

DANS la pratique courante des affaires du commerce et de l'industrie du caoutchouc, voici comment les choses se passent généralement, pour la vente par l'intermédiaire, et l'achat par le fabricant, d'un lot quelconque de caoutchouc. Rarement pour cette opération, l'acheteur est en relation directe avec le producteur de matière première; l'intermédiaire est une nécessité qui s'impose, sa présence est toute naturelle.

Ou bien le fabricant cherche directement à se procurer la gomme brute dont il prévoit le besoin à courte échéance, chez son fournisseur habituel, ou bien il est sollicité par des courtiers ou par des intermédiaires qui viennent le trouver avec une série d'échantillons de lots de différentes sortes et de provenances diverses. Que l'affaire se traite verbalement ou par correspondance, la situation est à peu près la même pour le fabricant, qui se trouve en présence d'un échantillon de la matière dont il va se rendre acquéreur. Un gros point d'interrogation se dresse à ce moment pour lui: va-t-il faire une bonne ou une mauvaise affaire? La question est là. Plusieurs coefficients entrent en jeu, qui vont influer sur la décision qu'il va prendre: besoin immédiat ou à terme, cours du jour, qualité de marchandise, etc. Chaque fabricant a sa manière, à lui propre, d'acheter, qui est la même au fond, puisqu'il s'agit d'apprécier la valeur industrielle du caoutchouc qu'on lui propose, et de voir si on lui en donne suffisamment pour son argent. Ce n'est pas une petite affaire, comme on le voit, que d'acheter cette matière première, et combien il est difficile d'exprimer les raisons qui vont influer sur la décision à prendre. L'acheteur regarde, palpe, tourne et retourne dans ses mains l'échantillon, souvent très petit, qu'on lui a soumis; il le sent, en prend un petit morceau entre ses doigts, lui fait subir des essais répétés de traction; il le roule, voit s'il est poisseux ou en passe de le devenir; il essaie de se faire un jugement rapide par tous les moyens dont il dispose, moyens qui sont, il faut bien l'avouer, on ne peut plus rudimentaires et limités. Lorsqu'une sorte de caoutchouc se présente, déjà connue du manufacturier pour avoir été employée par lui, ses hésitations sont évidemment diminuées dans une notable proportion, et, l'expérience aidant, l'affaire est vite traitée. Car il faut, la plupart du temps, que l'affaire soit enlevée, l'option n'étant accordée, aussi bien pour le vendeur que pour l'acheteur, que pour un délai très court; c'est donc une question de minutes, la réponse doit être donnée immédiatement par télégramme et confirmée de même, sous peine de voir l'affaire manquée.

L'achat fait, l'affaire en règle de part et d'autre, le fabricant se demande toujours s'il a fait une bonne ou une mauvaise affaire. Quand le saura-t-il? Quand sera-t-il définitivement fixé sur ce point? C'est bien simple: il saura réellement qu'il a fait une bonne ou une mauvaise affaire lorsqu'il aura employé sa marchandise, qu'il l'aura vulcanisée et livrée à son client, transformée en articles les plus divers. Et s'il n'a pas pris la précaution de conserver un échantillon de sa fabrication, il ne saura à quoi s'en tenir que si le client a à se plaindre de la fourniture faite, ce qui peut avoir lieu seulement quelques mois après la livraison.

Il faut dire que le producteur du caoutchouc se trouve, lui, dans une situation bien plus vague et imprécise, au point de vue de la qualité de son produit, que celle du fabricant de caoutchouc; car s'il n'a pas, lui producteur, à sa disposition, une usine en miniature, un laboratoire dans lequel il puisse essayer sa marchandise à la vulcanisation, il ne saura jamais rien, il ne pourra jamais se rendre compte si ses procédés de coagulation produisent de la bonne ou de la mauvaise matière première. Il ne pourra que continuer ses errements, sans savoir s'ils sont bons ou mauvais.

Ah! si le producteur et l'acheteur pouvaient se communiquer directement leurs impressions, un grand pas serait fait évidemment, dans le sens de l'amélioration des procédés de coagulation et de la qualité du produit. Malheureusement, il ne peut en être ainsi, à cause de la distance qui les sépare, et aussi pour une multitude de raisons qu'il est impossible d'expliquer ici.

Il est donc bien prouvé par ce qui précède que, pas plus le producteur de gomme élastique, que l'acheteur de ce produit, ne connaît généralement, d'une façon certaine, la valeur précise, la qualité exacte de la marchandise sur laquelle s'opère la transaction.

Et cependant cette situation, intolérable lorsqu'on y réfléchit un peu, que subissent producteur et employeur, ne peut durer indéfiniment; il faut bien qu'à un moment donné tout cela cesse.

Nous avons préconisé un moyen d'arriver à ce résultat, qui nous semble devoir satisfaire aux deux intérêts opposés, et connexes cependant, du producteur et du fabricant qui désirent: le premier, être renseigné sur la qualité de la marchandise qu'il offre, afin de pouvoir établir son prix de vente et maintenir le cas échéant ses prétentions; le second, être fixé sur la valeur industrielle du produit qu'il achète.

Ce moyen, suivant nous, consisterait dans l'établissement d'une marque pour chacune des sortes et provenances de matières premières, marque dont l'authenticité pourrait être appuyée par une analyse ou bordereau d'essais, provenant d'un laboratoire autorisé, spécialisé dans l'étude du caoutchouc, qui confirmerait les qualités et la valeur de la marchandise vendue sous la marque en question.

Il paraît bien qu'en adoptant cette manière de procéder, on pourrait déterminer les qualités d'un produit qui présenterait, pour le fabricant qui achète, toutes les garanties requises et correspondant au prix payé par lui. Le producteur, de son côté, on le comprend facilement, en retirerait le plus grand profit, sans qu'il soit utile d'insister davantage sur ce sujet.

# CONTRIBUTION A LA CONNAISSANCE DU MECANISME DE LA COAGULATION DE CERTAINS LATEX CAOUTCHOUCIFERES.

Par MM. F. Heim et R. Marquis.

Il est de la plus grande importance, au double point de vue théorique et pratique, de connaître le mécanisme de la coagulation de latex caoutchoucifères.

De cette connaissance dépend l'amélioration rationnelle des procédés de coagulation, partant la valeur commerciale des gommes.

Nos connaissances sur ce sujet restent singulièrement incomplètes; un très petit nombre de latex ont été étudiés à ce point de vue, et les théories émises pour l'explication du phénomène manquent, nous allons le voir, tout au moins de généralité.

Nous avons mis à profit l'envoi de latex de *Landolphia owariensis* et de *Funtumia elastica,* pour poursuivre l'étude du mécanisme de leur coagulation.

Le latex des plantes caoutchoucifères est une émulsion formée de fins globules, en suspension stable dans un liquide aqueux, sérum; ces globules contiennent la substance même du caoutchouc.

Sous l'influence de certains agents physiques ou chimiques, les latex caoutchoucifères mettent en liberté le caoutchouc qu'ils contiennent, sous forme d'un caillot élastique qui, en séchant, se rétracte et laisse échapper le sérum qu'il retenait; tel est, en gros, le phénomène de la coagulation; en aucun cas, le caillot une fois formé ne peut être remis en suspension dans le liquide même.

Il importe d'ailleurs, et c'est ce qu'ont négligé la plupart des expérimentateurs, de ne pas confondre ce phénomène de la coagulation proprement dite avec le phénomène très distinct de la précipitation du latex en fins granules isolés, qui se déposent facilement, mais peuvent être remis en suspension par agitation.

Ce phénomène physique, commun aux diverses émulsions, a reçu divers noms; le plus généralement adopté est celui de floculation; nous l'adoptons.

Il est essentiel de distinguer la floculation des latex caoutchoucifères et leur coagulation proprement dite.

(1) *Floculation.*

La floculation d'un latex caoutchoucifère consiste en ce fait que les globules, primitivement en suspension dans le sérum, se rassemblent et se précipitent, sans se souder les uns aux autres, chaque globule conservant son individualité propre.

La floculation est un phénomène réversible, en ce sens que la cause provocatrice venant à disparaître, les globules se remettent en émulsion et le latex reprend son aspect primitif.

Pour expliquer le phénomène de la coagulation, tel que nous l'avons défini plus haut, on a, dans ces dernières années (V. Henri), envisagé le latex comme une émulsion de signe négatif, c'est-à-dire dont les globules posséderaient une charge électrique négative.

L'introduction dans le latex qui les tient en suspension d'ions positifs provoquerait la coagulation.

L'addition au latex d'un acide correspondant à l'introduction d'ions positifs, ceux-ci neutraliseraient la charge électrique des globules, d'où coagulation; au contraire, l'introduction d'alcali dans un latex reviendrait à l'introduction d'ions négatifs OH; l'émulsion deviendrait indéfiniment stable, la coagulation impossible tant que persisterait l'alcalinité. Cette théorie électrique de la coagulation a été formulée à la suite d'expériences sur le latex d'Hevea; nous n'avons pu, pour notre part, faute de latex d'Hevea, faire porter nos essais sur ce latex; nous nous sommes adressés aux latex de deux espèces d'apocynacées: *Landolphia owariensis* et *Funtumia elastica*.

Pour ces deux latex—et nos conclusions ne peuvent pour l'instant s'étendre qu'à eux seuls—la théorie électrique s'applique au phénomène de la floculation, à ce phénomène seul, et non au phénomène de la coagulation *sensu stricto;* c'est ainsi qu'on peut produire la floculation du latex en déterminant la formation d'un précipité minéral au sein du latex par l'introduction d'électrolytes (lesquels, d'une manière générale, déterminent la floculation des émulsions).

Le latex, additionné d'acide minéraux, c'est-à-dire d'ions positifs, en proportions diverses et à concentrations variées, flocule, mais ne forme pas de caillot, ne subit donc pas la coagulation; l'acide acétique et trichloracétique provoquent floculation d'abord, coagulation ensuite; ce sont les deux seuls acides qui se conduisent ainsi. Nous verrons plus loin pourquoi les autres acides déterminent la floculation seule.

La floculation suit les lois générales applicables à toute émulsion négative.

La coagulation vraie n'est pas nécessairement précédée de floculation; dans certaines conditions, par exemple par addition d'alcool, la coagulation est instantanée par formation brusque du caillot.

La théorie électrique de la coagulation ne permet pas d'expliquer que ce phénomène se produise par l'action de substances, telle l'acétone, qui ne sont pas des électrolytes.

(2) *Coagulation.*

La coagulation proprement dite est un phénomène essentiellement distinct de la floculation. Il consiste en la soudure des globules en un caillot unique, élastique, de caoutchouc. Contrairement à la floculation, la coagulation est un phénomène essentiellement irréversible.

Pour expliquer le phénomène de la coagulation proprement dite, plusieurs théories ont été émises:—

Celle de Weber invoque, comme cause déterminante, la précipitation de matières albuminoïdes présentes dans le latex.

Cette théorie, adoptée par nombre d'auteurs, est certainement inexacte en ce qui concerne les latex d'apocynacées, visés dans cette note.

Les latex, en effet, ne coagulent pas par addition des substances qui précipitent habituellement les albumines; telles que le tannin et l'aldéhyde formique; l'addition d'aldéhyde formique ne détermine que la floculation et au bout d'un temps assez long.

Transforme-t-on, en solution hyperalcaline, les albuminoïdes en alcali-albumines, précipite-t-on celles-ci par l'alcool, les latex ci-visés fournissent encore un coagulum de caoutchouc; la coagulation n'est donc pas sous la dépendance de la précipitation des albumines.

Les substances qui coagulent à froid ces latex sont les alcools méthylique et éthylique, l'acétone, les acides acétique et trichloracétique. Il est remarquable que ces substances soient toutes des dissolvants des résines.

On est dès lors conduit à se demander si ce n'est pas à cette seule propriété que ces substances doivent leur pouvoir coagulant.

Notons tout d'abord que leur action n'est pas due à des propriétés fonctionnelles, puisque d'autres alcools tels que le glycol et la glycérine (polyvalents), d'autres acides tels que l'acide lactique (oxyacide), l'acide pyruvique (acide cétonique), ne coagulent nullement le latex. Mais ces corps ne sont pas des dissolvants des résines.

Si la seule dissolution des résines est la cause de la formation du coagulum, celui-ci doit être évidemment provoqué pas des solvants qui, insolubles dans l'eau, ne pourront en aucune façon modifier la composition du latex et dont le seul rôle sera limité à la dissolution de la résine. C'est ce que l'expérience confirme.

Le latex de *Funtumia elastica* est, en effet, coagulé instantanément à froid par agitation avec l'alcool amylique, l'aniline (corps, il est vrai, légèrement solubles dans l'eau; mais dont la solution aqueuse est sans action sur le latex), l'alcool phényléthylique, l'acétophénone, l'aldéhyde benzoïque, la quinoléine. Ces corps, et on pourrait sans doute en trouver bien d'autres, appartiennent comme on le voit à des fonctions chimiques diverses, leurs caractères communs sont: d'être insolubles dans l'eau, de ne point attaquer le caoutchouc et de dissoudre les résines. Il est d'ailleurs facile de se convaincre que cette dissolution a effectivement eu lieu; il suffit de distiller dans le vide à basse température l'alcool amylique ayant agi comme coagulant, pour obtenir un résidu de résines. On peut aussi, si on a employé la quinoléine, dissoudre celle-ci dans un acide dilué, les résines restent insolubles; c'est même là un moyen commode de doser la résine directement dans le latex.

Ainsi donc l'enlèvement des résines provoque la formation du caillot. Tout se passe, en somme, comme si le caoutchouc (ou le carbure inconnu qui lui donne naissance, soit par polymérisation spontanée, soit par un autre mécanisme inconnu) était composé de petits globules entourés d'une mince pellicule de résine (pellicule vue au microscope par Weber et qu'il avait supposé être de la matière albuminoïde). Cette pellicule disparue, les globules de caoutchouc arrivent au contact, se soudent et forment le caillot.

On comprend alors comment agissent l'alcool, l'acétone, l'acide acétique, quand on les ajoute au latex. On remarquera d'abord que ces corps n'agissent qu'à une certaine concentration. Nous avons vérifié, en introduisant de petites quantités de latex dans des volumes relativement considérables d'alcool, à des degrés divers de concentration, que la coagulation ne commence que lorsque l'alcool est à 45° C. Dans ces conditions, et par suite de l'attraction bien connue exercée par le corps soluble sur le solvant, la pellicule de résine dissout une certaine quantité d'alcool (ou d'acétone ou d'acide acétique), elle devient alors perméable à l'eau qui, entrant par osmose dans le globule, fait éclater la pellicule et libère le caoutchouc.

Il semble donc qu'on puisse adopter à titre provisoire et comme guide pour les recherches futures la théorie suivante.

Les globules du latex sont constitués comme suit:

Une masse centrale de substance-mère du caoutchouc, entourée d'une pellicule périphérique extrêmement mince de résine.

Cette pellicule de résine isole les unes des autres les masses centrales des diverses globules et empêche leur soudure. Vient-elle à être détruite, les masses se réunissent et se soudent en un caillot de caoutchouc.

La destruction de cette pellicule peut avoir lieu:

1° Par action de la chaleur, qui la fait fondre ou éclater par dilatation de la masse centrale (coagulation par la chaleur).

2° Par action d'un dissolvant, qui la dissout ou qui, l'imprégnant, permet au sérum de la pénétrer per osmose, ce qui provoque son éclatement (coagulation par l'alcool, l'acétone, l'acide, acétique, etc.).

3° Par une action mécanique qui la brise (coagulation par barattage). On trouve ici l'explication d'un phénomène que l'un de nous a observé antérieurement avec feu Henriet que les globules floculés coagulent au bout d'un certain temps (ce qui n'est d'ailleurs pas un cas constant) ou par compression de la masse entre les doigts. Dans ce dernier cas la pellicule périphérique se trouve brisée. Dans le cas de la coagulation spontanée on peut penser que la pellicule étant probablement sinon liquide, du moins semi-fluide ou assez molle, la pression mutuelle des globules par simple action de la pesanteur suffit au bout d'un certain temps pour rompre la pellicule et provoquer la coagulation.

4° Un seul cas de coagulation, celui par enfumage à la mode du Para, reste en dehors de cette théorie, à moins que la chaleur seule n'entre en cause, ce qui nous ramènerait au premier cas. L'étude expérimentale de coagulation par enfumage tranchera la question.

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