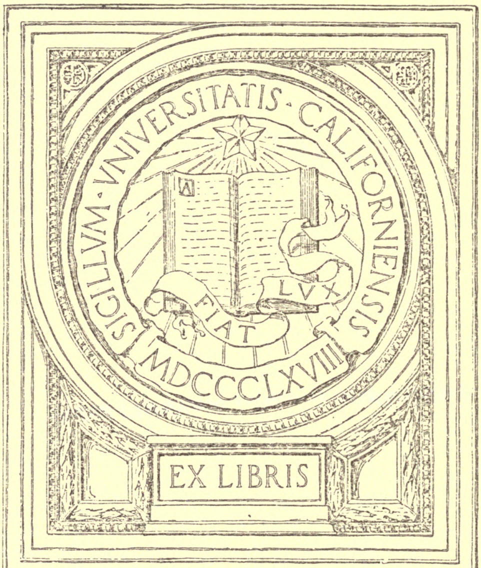
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INTERNATIONAL ASSOCIATION FOR TROPICAL AGRICULTURE

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

Transactions of the Third International Congress of Tropical Agriculture

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PREFACE.

THE first volume of *Transactions* of the Third International Congress of Tropical Agriculture contains the papers presented to the Congress on the following subjects: Technical Education in Tropical Agriculture; Organization of Agricultural Departments in Relation to Research; Agricultural Credit Banks and Co-operative Societies; Sanitation and Hygiene on Tropical Estates; Legislation against Plant Diseases and Pests; Cotton; Fibres; Rubber. The present volume contains the remainder of the papers selected for publication.

As in the case of Vol. I, the papers contributed by the Portuguese Section of the International Association for Tropical Agriculture in Lisbon are not included, as they have been printed separately and distributed to members of the Congress. The papers from Portugal relating to the subjects included in the present volume are as follows:—

"Monographie de la Société du Madal, Chr. Thams et Cie." Par Théophile Bonnet.

"La Guinée Portugaise." Par Carlos Pereira.

"La Terre, le Capital et le Travail dans l'Inde Portugaise." Par Dr. Caetano Gonçalves.

"La Main-d'œuvre aux Iles de Cabo Verde." Par Francisco de Paula Cid.

"Organisation et Recrutement de la Main-d'œuvre dans la Province de St. Thomé et Prince." Par José Joaquim Xavia de Brito.

"La Main-d'œuvre indigène à Angola." Par J. A. Alves Roçadas.

"Organisation du Travail et Fournissement de la Main-d'œuvre dans la Colonie Portugaise de Timor." Par Jayme Augusto Vieira da Rocha.

"Contribution pour l'Étude des Herbages d'Angola." Par Joaquim Pratas.

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THE PRODUCTION OF WHEAT IN THE TROPICS.

By A. E. Humphries.

Past President of the National Association of British and Irish Millers.

The quantity of wheat produced in tropical countries is relatively unimportant. In some it is indigenous, and in those cases interest centres on the efforts of scientists to supplement the empirical knowledge acquired by many generations of growers; in others it is exotic, and the story of the difficulties encountered, the efforts made, and the success achieved in introducing and adapting wheat to entirely new environments is full of interest.

Wheat flourishes in temperate climes, and is regarded as a most important product of the temperate zones, but it must not be forgotten that temperate climes exist also in the tropics; altitude may be as important as latitude, so we find that an appreciable quantity is already produced there. Let me briefly review the position from that point of view.

America.—Although *Mexico* does not produce enough for her own requirements, she does, nevertheless, grow about 2,000,000 quarters per annum, almost entirely in the torrid zone, but on the central tableland, at an altitude of 6,000 to 10,000 ft.

The *Central American States* produce moderate quantities of wheat, though not enough for their own requirements, and comprise districts in which the climate and soil are favourable to wheat production. Indeed, it is said that in the provinces of Copan and Intibuca, in Honduras, and on the highlands of Guatemala, the conditions are favourable, or very favourable, for that purpose.

The *West Indies* appear to depend wholly on outside sources for their cereal supplies.

In *Venezuela* the production of wheat is very small, but "fine crops" are produced in the high tablelands and valleys of the mountainous districts of Western Venezuela.

In *Colombia, Peru,* and *Bolivia* a small quantity of wheat is produced, quite insufficient for local demands; but *Ecuador,* situated though it is on the Equator, produces enough for its own requirements, and in some years exports small quantities to Peru.

An encyclopædia says that wheat is grown in *Guiana,* but I have never seen a reference to it in corn trade literature.

Brazil has an experimental farm at Victoria Espiritu Santos, and has succeeded in growing there annually a small quantity of wheat, but the results up to now appear to be poor. Wheat has been grown in Minas Geraes. Other experiments have been made, and some are now being made near San Paulo, but, substantially, no wheat is produced in tropical Brazil. A little is grown in the State of Rio Grande do Sul, but that is in the temperate zone. Large quantities of wheat are imported into Brazil from the Argentine.

Sudan.—In recent years a good deal of attention has been given to wheat growing in the Sudan, and I will later on refer in some detail to the results obtained, but at this juncture all I need say is that substantial quantities are being produced in the province of Dongola, and that in 1912-13 the total area under wheat in the Sudan was returned as 30,000 acres.

Abyssinia.—In Abyssinia wheat appears to have been for a long time one of the staple crops, and bread one of the regular articles of diet. Wheat can be grown at low altitudes as well as on the higher lands; but, so far as I am aware, no attempt has been made to state in figures the quantity produced in the country, none is exported, and small quantities of wheat and wheaten flour are imported. To me the most interesting point concerning Abyssinian wheat is the existence of a purple skinned variety. It is used especially in the manufacture of a bread known as Dabo, which resembles rye bread.

British East Africa.—I have not seen any figures giving the total quantity of wheat produced in the East African Protectorate and Uganda, but a report on agricultural matters says that 3,000 to 4,000 acres were sown in one recent season on the "plains of Njoro." The natives appear to prefer maize, beans, millet, sesame, sweet and English potatoes, yams, bananas, etc., all of which can readily be grown in the country. White people want wheaten products, and there is a large demand for them, but Mr. Macdonald, the Director of Agriculture, E.A.P., in a letter which I have received from him, says that "with the better control of stock diseases, cattle raising, dairying, and pig breeding are being given more attention than in the past, and are likely to become more important branches of farming than wheat growing." However, certain varieties of wheat appear to thrive on the highlands of the interior, and I will refer to the matter later on.

Belgian Congo.—I have seen some interesting records of wheat growing in the Katanga district of the Belgian Congo, but the quantity produced appears to be very small.

Rhodesia.—The white man needs wheaten products, and the natives "who have come in contact with civilization prefer wheaten or Boer-meal bread to their ordinary diet, while Cape boys and natives of a more advanced type from the South African Union, and employed in Rhodesia as transport drivers, usually receive a daily ration of unsifted wheat meal (Boer meal), which they make into bread. There thus already exists in Rhodesia a considerable demand for wheaten products, but this is mainly met by the importation of flour from Canada and Australia, and Boer meal grown in the South African Union . . . ." "There is no variety of wheat indigenous to Rhodesia, or, indeed, to any other part of South Africa, nor is the crop ever grown by the Rhodesian natives," but a great deal of experimental work has been done by the Rhodesian Department of Agriculture, and the results obtained indicate that Rhodesia in time will produce enough wheat to satisfy its own requirements, and be able to export some into the Belgian Congo State.

Madagascar.—Small quantities of wheat have been produced on the higher lands in the interior of Madagascar, and flour of good quality has been produced from it, but difficulties in transport and the lack of a market for the by-products of milling prevent the profitable production of wheat, and the flour required is imported from France.

India.—The man in the street probably regards India as a tropical country, but only a moderate proportion of her wheat crop is grown actually in the tropics. The wheat-growing districts of Bengal are situated in the north of that province, and are, therefore, not in the tropics. Excluding Bengal, Central India and Sind, and the great wheat fields north of those provinces, I find that about 6,000,000 of India's 30,000,000 acres, or, say, 20 per cent. of the whole area under wheat, is within the tropics. The total crop of India is about 45,000,000 quarters per annum, and of that quantity about 6,000,000 quarters are produced actually within the tropics. The yield per acre for the whole of India is about 12 bushels, and for tropical India about 6¼ bushels per acre. The smaller crop in the latter may be largely due to the fact that the great and beneficent work of irrigation is performed principally north of Cancer, but to some extent it is due to the fact that in tropical India the wheat has specially little time to tiller. Burma has about 40,000 acres under wheat. The advent of British troops seems to have been the immediate reason for the introduction of the white man's cereal into that country.

Australia.—I shall be referring later on to investigations which have recently been made into the possibilities of tropical Australia (Northern Queensland, Northern Territory, and Northern West Australia) as producers of wheat, but at this juncture I may dismiss them with the remark that substantially no wheat is produced there. The Commonwealth Year-book says there were 2 acres under wheat in the Northern Territory in 1911-12.

For the purposes of the foregoing summary I have searched a good deal of literature, but beyond mention of the facts that some wheat is grown in Nigeria and German South-West Africa, I have seen nothing calling for recital herein concerning the parts of tropical Africa to which I have not referred.

I wish now to direct your attention specially to the work concerning wheat accomplished and progressing in Rhodesia, British East Africa and tropical Australia, where it is exotic, and in India and the Sudan, where it is indigenous.

Rhodesia.

The distinction I have drawn between the countries where wheat is exotic and indigenous is important. Empirical information, if it be derived from sufficiently long experience, is valuable. A modern investigator may encounter great difficulty in convincing growers of indigenous plants that their methods are capable of improvement, but he does at least start his work as to possibilities upon a basis of results already obtained, whereas the introducer of an exotic has little or nothing to guide him in his operations. This was the case in Rhodesia. Until quite recently no one had grown wheat there.

Starting apparently on the assumption that it was likely to be a summer crop, it was grown during the rainy season (October to April), but the attempts were rendered unsuccessful by rust. Thus it came to be regarded as a crop for the dry winter months (May to September), and irrigation seemed to be essential. The next stage was the discovery of the fact that considerable areas of low-lying land, particularly in the granite formation, retained sufficient moisture throughout the winter months for the growing of winter crops without irrigation, so it is being grown as a winter crop both under irrigation and as an unirrigated crop on moisture-retaining soils. Even so, however, the production is still far below the requirements of the country, and the Department of Agriculture has, therefore, devoted much attention to the creation of rust-resistant varieties which can be grown during the rainy season and be rotated with maize. It is very interesting to note that, although several varieties, including Medeah, Belaturka, and Zwaartbaard, failed entirely owing to rust, some varieties were found which behaved satisfactorily. The Report of the Government Agriculturist and Botanist for the year 1912 contains the following reference to wheat: "The great problem . . . . is the prevalence of rust, and the attempt to solve this by the creation of hybrids has yielded promising results. Fifteen cross-bred strains of wheat, of which in most cases a variety known as Victoria was one of the parents, were grown as summer crops, and were resistant to rust and yielded well. . . . The grain of the hybrid shows a great improvement in quality as compared with that of Victoria wheat, and several strains promise greater rust resistance. . . . In all fifty-two different strains of wheat were under trial." Last month I received information that most satisfactory progress has been made with this work, and that "the Department possesses several varieties which have been grown successfully as summer crops for the last three to five years." I am indebted to Dr. Eric Nobbs, the Director of Agriculture, and to Mr. Godfrey Mundy, the Government Agriculturist and Botanist, for the information upon which my remarks are founded, and the former includes a memorandum he kindly sent me as follows: "There thus appear reasonably good prospects of summer wheat becoming a staple Rhodesian crop in the not-distant future, and if this can be achieved the country will well be able to supply its own needs in regard to wheaten products.

"The type of wheat found most suitable to Rhodesia is the common wheat (*Triticum sativum*), but European varieties have not been successful. Durum wheats have been discarded, and quick maturing varieties alone are now being grown.

"Rust and smut are the only diseases by which the crop is as yet attacked.

"The average yield under present methods of farming, and whether as a summer or a winter crop, is about 14 to 15 bushels per acre."

As a commercial proposition wheat has had to compete principally with oat-hay and maize. The latter is the standard summer crop, and has predominated to such an extent that Southern Rhodesia was described a few years ago as "practically a one crop country." Now, owing to the success of scientific work, wheat growing has advanced in Rhodesia from the category of possibilities to that of probabilities.

British East Africa.

A good deal of experimental work has been done with wheat. In one year 200 different varieties were tested at one experimental station, the Kabete Government Farm. Experiments have also been made at other centres, and in this way information has been gained as to the districts which are suitable for wheat growing, and as to the varieties which do well in them. For instance, the loose friable soils of the highlands appear to be more adapted to the raising of barley than of wheat. Where the latter has often failed to produce a yield through the ravages of rust, barley has given good returns.

Even in those districts where wheat is likely to be grown most of the varieties tried have been found to be useless, or relatively unfit, killed or damaged by rust. But there are notable exceptions. For instance, Rieti, grown on a fairly large scale, has for several successive seasons proved itself to be a fair yielder and only moderately susceptible to rust. Its disadvantages are that its straw is weak and does not stand up well, its ears are bearded and very lax, and the flour it yields is not highly esteemed. Bobs yields more grain per acre, and it is of superior quality; Gluyas, when first introduced, also did well, but both these Australian varieties have since become most susceptible to the attacks of rust, and cannot now be relied upon. Federation Thew and an Egyptian wheat also appear in the category of apparently satisfactory varieties, but Durums were very susceptible to rust, and some Indian and North Russian wheats tried failed to give satisfaction.

In view of such results hybridizing and Mendelian selection were adopted, and the results so far recorded are most interesting and satisfactory.

At the outset of such work it was thought that only two forms of rust occurred in the country, viz., black rust (*Puccinia graminis*) and yellow rust (*P. glumarum*). Mr. Evans, the Government Botanist, having noted that certain varieties were susceptible to one of these rusts, and apparently immune or highly resistant to the other, proceeded to make crosses in the hope and expectation that among the progeny he would find one or more forms immune or highly resistant to both. It is recorded at a later stage that orange rust (*P. triticina*) has been found, and Mr. Evans proposes to proceed on the same lines to seek for a variety which is immune to all three. I need hardly say that the work will command a great amount of interest and sincere hopes for success. Up to now I have seen no announcement of the complete story, but in the Annual Report for 1912 of the Department of Agriculture, British East Africa, it is recorded that some of the new types produced by hybridizing and selection have for the past two generations resisted the "black stem rust" (*P. graminis*), the worst fungoid enemy to wheat in the country. A most encouraging result. I note in this connection that rust has been known to appear in wheat grown for the first time on virgin soil when no other wheat was growing within a thousand miles of it.

Other wheat pests have been encountered, *e.g.*, green fly (*Toxoptera graminum*) and two species of beetle (*Phrynocolus crispatus*, Fairm., and *Gonocephalum contractum*, Gerst.), but the outstanding fact is that good yields, ranging from 20 to 36 bushels per acre, have been obtained.

There are two distinct rainy seasons in the country, and it is possible to obtain two crops of wheat in one year.

For instance, Rieti was sown in May, 1905, and harvested in the following September. It was then sown again at the same station, and harvested in March, 1906. I have seen other records showing the possibility of getting two crops in twelve or fourteen months; the one I have used shows they have been secured within ten or eleven months. This rapidity of reproduction is very useful to the breeder, but it does not appear to be good for commercial purposes. A constant succession of wheat crops appears to encourage pests, and a rotation of crops is recommended. One that is being tested is maize, wheat, beans, linseed.

Manurial tests are being made, and, in spite of the apparent richness of the soil, an application of dung or compost seems to give greatly increased yields. The addition of phosphatic manure has a wholly beneficial effect on the wheat crop, for it strengthens the straw and renders it less liable to rust. No doubt the trials will be repeated on rust-resistant varieties.

The environments required for successful commercial production are large, slightly undulating, open spaces at a considerable altitude where implements and machinery can be used to advantage. These are found near Njoro. Already some thousands of acres are producing wheat in that neighbourhood, and the employment of the modern machinery now available makes it possible to produce a crop at a low cost and without the employment of many farm hands. One of the Reports I have read says: "The impetus given by wheat growers in the Njoro district and the probable profits should induce others in the vicinity to take up wheat growing, and it is probable that the whole district between Njoro and Naivasha may in the near future be under this cereal. The vast plains stretching from Machakos to Nairobi, especially considering the flatness of the land and its freedom from timber, offer every facility for growing wheat on a large scale."

Tropical Australia.

Queensland.—From publications which the Official Secretary to the High Commissioner for Australia has sent me, I find that the 100,000 acres under wheat in Queensland are situated wholly in the temperate zone, and I may add in passing that only about 16 per cent. of the total area under cultivation in that State is situated in the tropics. I would also like to add that at the State Farm, Roma, which is about 200 miles south of Capricorn, Campbell's system of dry soil farming has been tried, and that in a dry season on land so treated about 19 bushels of wheat per acre had been obtained. The manager records that the rainfall in the four months, May, June, July, and August, which covers the period from sowing to earing, was 1·55 in., and that from the end of August till October, when the crop was harvested, it was 2·18 in. Detailed figures as to soil moisture are also recorded. For the four months the average figures for the top 6 in. are: Ordinary cultivation, 6·75 per cent.; Campbell's farming, 10·07 per cent.; for the following six weeks the figures are 9·83 and 14·61 per cent. respectively. The records I have seen do not say what yield was obtained from the same variety grown by ordinary methods, but the manager writes as follows: "So far the results do not point in favour of the Campbell's system as advocated, as the annual yields have been equal to, and in some instances better, than the biennial yields off the Campbell block for half the labour expended in preparation." The verdict so far appears to be unfavourable, but I have thought it desirable to mention the record, because it is the first I have seen referring to such tests made almost within the tropics, and labour in some parts of them is cheap.

Northern Territory.—Mr. F. B. Guthrie, of Sydney, from whom at intervals I receive appreciated letters, tells me that the late Director of Agriculture for New South Wales, who recently returned from a trip in the Northern Territory, found (1) that a "Swedish farmer ninety miles inland from Port Darwin obtained some seed from India, and got good grain on light sandy soil and without rain for six months.

"(2) That he saw some wheats grown on the Roper River about 300 miles further inland, results satisfactory, but only experimental.

"(3) That he considers there is plenty of good wheat land in the Territory, especially further south in the Barkley Tablelands."

Western Australia.—The Commissioner for Tropical Agriculture, Mr. A. Despeissis, made in 1909 and 1910 an overland tour through tropical Australia to examine at first hand the conditions prevailing there. He writes that "wheat promises in an average season to be a profitable crop as far north as the Gascoyne, and sheaves of wheat I have brought back from gardens along that river stood 4 ft. high, grown without irrigation. Sown on carefully prepared fallow, it should in a fair season yield a heavy crop of grain. The problem of extending our wheat fields as far as the Gascoyne is one deserving serious attention. I entertain no doubt whatever that the prospect is a sound one, as far at least as Hamelin Pool and Sharks Bay, provided wheat growing is combined with sheep grazing. In a bad season the sheep could be turned into the failing crops, while, on the other hand, in unfavourable years yields as good as, if not superior to, those obtained in the most favoured localities of our wheat areas would be secured." I ought to point out that the Gascoyne is almost but not quite in the tropics.

There is an "immense area of rich land" situated in these drier zones, and the discovery or production by hybridizing of varieties of wheat which will thrive on a very small rainfall would enormously increase the output of Western Australian wheat, and very appreciably increase the quantity available for the importing countries.

India.

Most valuable literature has been published concerning the production of wheat in India, therefore I need only deal with the more recent work accomplished in that country, and emphasize a few points which are in my opinion specially important.

Wheat growing appears to be one of India's ancient industries, and the indigenous varieties have characteristics specially their own. In most countries wheat is matured and harvested in a period of decreasing temperature; in India those stages are passed in a time of rapidly increasing temperatures, and most varieties of great repute and value elsewhere are useless there. Should wheat grow slowly and the stage of grain formation be two or three weeks late, the plant will probably shrivel and be fruitless. For instance, Canadian Red Fife, which grows rapidly in England and Canada, is useless to Indian farmers, because it does not grow rapidly enough there.

Wheat straw in most countries is used for litter or is useless, but in India it has to become, as bhusa (chaff), food for cattle. Hybridizers in many countries might do worse than use some Indian varieties in an attempt to impart to their wheats a straw which can be freely used as cattle food, but it must not be forgotten that varieties of great value in India may be useless elsewhere. And the converse is true, for we find Howard saying that "the introduction of exotic wheats into India has been a long record of failure." Indeed, one is driven to the conclusion that in countries where wheat has been grown for centuries it is wise to esteem highly the empirical knowledge acquired by generations of growers, and to be slow in discarding existing methods of cultivation. European methods have been tried in India and discarded; it has been found, on most points of agricultural practice, better to supplement and adapt rather than to discard native customs in this connection.

These considerations have a bearing on the choice of varieties. For instance, threshing can best be done by bullocks; the wheat must therefore be allowed to become fully ripe, and as a consequence varieties are specially wanted which will hold their grain with a minimum of shedding when dead ripe. Nor must the breeder, in attempting to stiffen the straw, overlook the fact that it has to become food for cattle. Again, dung is used as fuel; but in India nitrogen is a "limiting factor" as to yield, and farmyard manure appears to be the best fertilizer which can be added to the soil; so the problem on this point is to find a substitute for dung as fuel. The native, however, discovered long ago that leguminous plants acted as fertilizers, and it is a common practice to grow leguminous plants in rotation or actually mixed with wheat itself. In the Narbada Valley, situated in the tropics, it is customary to grow wheat year after year without rotation, manure, or irrigation, but the natives almost invariably mix a proportion of gram with the wheat, and the soil appears to be more fertile now than it was in 1864. Even the leguminous weeds which grow freely in the wheat fields of the Punjab are credited with improving the crops by means of the nitrogen which they add to the soil.

At this point one of the very latest scientific discoveries comes in. The native usually allows his land to remain unploughed for a considerable time after the wheat has been removed, but it was noted at Pusa that if the soil were ploughed soon after harvest and exposed to the sun and wind during the intensely dry, hot weather of April, May, and June an astonishing effect was produced on the succeeding wheat crop, which appeared to have been manured with some nitrogenous fertilizer. The key to this riddle was subsequently supplied by Rothamsted. Apparently the sun in India supplies sufficient heat to kill off or diminish harmful soil organisms, and in that way adds to the supply of available nitrogen. One wonders to what extent the growers and consumers of wheat can benefit by this application of modern science—in other words, to what extent can sunshine replace the dung cart in hot countries. Does it provide one explanation for the benefits of fallowing in temperate climes? Be that as it may, the variation of native practice as to the time of ploughing led at Pusa to a notable increase in the following crops.

In India, and especially tropical India, the rust problem is of the greatest importance. In 1896 Watt estimated the annual loss from rust in India at upwards of 10 per cent. It varies from season to season, and is much greater in some districts than in others. For instance, "the damage done in the great wheat-growing tracts of the North-West is generally slight, while in Bombay, the Central Provinces, and in parts of the United Provinces and Bengal the crop may be reduced 50 per cent. or even more." Nor is the prevalence of rust a modern occurrence, for in 1839 Sleeman, referring to rust in the tropical Central Provinces, wrote: "I have seen rich sheets of uninterrupted wheat cultivation for twenty miles by ten in the valley of the Narbada so entirely destroyed by this disease that the people would not go to the cost of gathering one field in four," and further: "I believe that the total amount of the wheat gathered in the harvest of 1827 in the district of Jubbulpore was not equal to the total quantity of seed that had been sown."

I need not go on piling up evidence of the harm done by rust. Everywhere it is the enemy, and more than usually dangerous in tropical India. Nor have I the time or inclination to review the botanical side of the rust problem. At one time I felt inclined to draw a moral from what I had read concerning it, but discretion came with increased knowledge, and I will leave the botany of rust to specialists, including the physiological problems concerned with it. I may, however, refer to the latest work done in India to combat this pest. The first stage in the most modern attack on this enemy was to sort out the native varieties and note with precision how each was affected by rust in a succession of seasons. Working in the Central Provinces, G. Evans, of Hoshangabad, noted that some of the varieties commonly grown in that part of the tropics, such as White Pissi and Jalalia, were very susceptible to rust, whereas some little known varieties, such as Soharia. were highly resistant. The Howards, further north, not only sorted out the native wheats, but introduced some kinds which had in Europe been found to be immune or highly resistant to rust, such as Einkorm, Emmer, and a variety known in England as American Club, found at Weybridge growing in a plot raised from seed taken from a commercial grade of United States wheat. These wheats were grown with a measure of success, and crosses were made at Lyallpur between several varieties of Emmer and some native wheats which, apart from rust, were otherwise desirable. But the Howards went still further. They found when crosses between these exotics and native wheats had been made that the progeny of the first generation did not thrive in India, so they enlisted the help of Professor Biffen, and in 1910 crosses were made at Cambridge between the rust-resistant wheat and some Indian varieties. This arrangement worked successfully, and the progeny sent to India after the F_1 stage (first generation) had been passed have thrived in India. I need not recite to this audience the methods and principles of hybridizing and Mendelian selection. Suffice it to say, that selected strains found in the progeny of the crosses have inherited and retained, when propagated in India, the desired characteristic of rust resistance; and the Imperial Economic Botanist, in his last published Report, after mentioning that two series of these hybrids were then in the fourth generation, says that it "is by far the most promising material yet obtained at Pusa, and it is more than probable that the strong straw, rust resistance, and general vigour and hardiness of the English parent has been, as it were, introduced into Indian wheat." That immunity and susceptibility to rust is a Mendelian unit, and that by the application of Mendelism the rust problem is likely to be solved seems to me one of the most important discoveries of modern times, and I am exceedingly pleased that the first public announcement of it was made at a meeting of British and Irish millers over which I had the honour of presiding.

Another important application of Mendelism concerns the milling and baking qualities of wheat. The theory is that "quality of endosperm" can be handled in hybridizing as a separate Mendelian unit, and therefore can be transmitted from an otherwise undesirable parent to an otherwise highly desirable child. Of course, I know that the theory has been attacked; but India, including tropical India, has provided the best proof on a large scale of its soundness. The theory was first enunciated in England, and was first applied to English wheat, but India has achieved a great and important result in applying this point more rapidly than we have been able to do at home. The reason for that is interesting. To obtain new varieties possessing the quality of endosperm we desire in England, one of the parents has to be an exotic wheat, and we do not know until it has been grown for several or many successive seasons how it will behave in its new environment, or whether the variety itself is homogeneous as to "quality of endosperm." The wheats hitherto exported from India have good points of milling and baking quality, but on the whole are relatively inferior according to European or American standards of excellence. But the Howards and Leake, in sorting out the botanical jumble of Indian wheats, found that some indigenous varieties were of first-class quality, and they proceeded to apply the Mendelian theory. I have for several successive seasons tested the parents and the progeny, and I can, without the slightest hesitation, say that the new varieties are of the highest class, much superior to the Indian wheats of commerce hitherto exported. Up to now the natives for their own consumption did not like the varieties grown for export, but the new varieties are acceptable for both purposes. This is important, seeing that only 15 per cent. of the Indian wheat crop is exported. Furthermore, the quality remains first-class when the wheat has been grown on properly irrigated land. Best of all, the new varieties give the quietus to the criticism that it is impossible to combine fine quality and high yielding capacity in any one variety, for not only is their quality first-class, but the yields are most satisfactory.

For lack of time I must refer inquirers to official publications for detailed information concerning various parts of India, but I must mention the following facts concerning tropical India. On the black soils of the Central Provinces the yield per acre very rarely exceeds 600 lb. English, whereas recently yields very greatly in excess of this have been obtained with the new varieties. At Tharsa last year, one known as Pusa 7 yielded 1,240 lb. per acre. The finest Indian wheat I have ever seen was grown at Raipur in 1911, and other samples grown then and in other seasons at Tharsa and Hoshangabad are of first-class quality. I must leave this most interesting part of my subject by saying that the prospects of successful wheat production in India have been very greatly improved in recent years, that the successes already achieved are substantial, and still greater ones are in sight.

Sudan.

The principal food of the Sudanese is dura, and as yet the natives show no preference for wheat. They eat wheaten products when for some reason or another the supply of dura is small. To a very large extent agricultural production in the Sudan depends on irrigation, and on irrigated estates a three-course rotation is usually followed: cotton, wheat, and some leguminous crop. Of these three cotton is regarded as the important revenue-producing crop, and is preferred to wheat for two principal reasons: one, that it can be transported more easily; the other, that wheat land must be prepared and sown in November or early December in the beginning or middle of the busy cotton-picking season. "For such reasons the Sudan Plantations Syndicate, Ltd., who cultivates 10,000 feddans (about 10,000 acres) in Berber Province, the largest single block of cultivation in the Northern Sudan, are abandoning wheat cultivation entirely, and it is probable that the same thing will happen in the large area to be brought under the Gezira Irrigation Works."

However, the recent history of wheat production in the Sudan is as follows:—

The total area under wheat in	1909-10	was	19,681	feddans
,, ,,	1910-11	,,	26,972	,,
,, ,,	1911-12	,,	29,193	,,
,, ,,	1912-13	,,	30,039	,,

a record which shows a substantial and progressive increase.

The area for 1912-13 was distributed as follows:—

In the	Halfa Province	2,563	feddans
,,	Dongola ,, ...	16,300	,,
,,	Berber ,, ...	8,550	,,
,,	Khartoum ,, ...	1,366	,,
,,	White Nile ,, ...	686	,,
,,	Blue Nile ,, ...	217	,,

The Director of Agriculture and Forests, to whom I am indebted for much valuable information, tells me that wheat cultivation may increase somewhat in the North on the riverain estates of Khartoum, Berber, Dongola, and Halfa Provinces, and will certainly do so to some extent, as the basin irrigation schemes are perfected in Dongola, but that owing to distance of transport and the cost of production the important irrigation scheme south of Khartoum is not likely to lead to an export trade in wheat. But good crops can be grown there. For instance, I find in the records mention of yields ranging from 14 to 38 bushels per acre, the 38 bushel one produced under irrigation in the Gezira ("that vast plain now to be brought under irrigation in Blue Nile Province"). Rust and smut frequently occur, "but not to such an extent as to be a serious hindrance." Wheat must be grown under irrigation, either artificial or by the rise of the Nile in flood. It cannot be grown as a rain crop, for the rainfall is restricted to the summer months, when wheat is unable to withstand the extreme heat. In 1909 I made milling and baking tests of six sample lots of wheats grown in the Sudan. I found some serious blemishes in them, such as excessive dirt and irregularity of type, but they possessed good points, and were similar to the Indian wheats of commerce. I was much interested in learning subsequently that I had placed at the head of my list "a sample of the wheat grown all over the Dongola Province" by the native cultivators. It was very far from being true to any one type, but some of the varieties it comprised must have possessed fine quality of endosperm, although I suppose they were indigenous. We see, therefore, from this brief summary of Sudanese wheat production, that the results are not unfavourable, and that under certain conditions wheat may become a much more important crop than it is at present or that it is likely to be in the near future. The Government of the country appears to have these possibilities in mind, and is carrying on much experimental work.

General.

When I began to prepare this paper I was afraid lest it would be profitless and uninteresting to all concerned, a case of "trying to make bricks without straw," for corn trade literature is, apart from India, almost silent concerning the "Production of Wheat in the Tropics." But as I searched through much literature, a work in which I was greatly assisted by Dr. Henry and other officials of the Imperial Institute, and received the replies to my inquiries from the authorities whose names I have mentioned in the course of this paper, I began to realize that, in fact, my subject was interesting, and that its potentialities are important. From time to time we are told that the world will soon be producing an insufficient supply of wheat. In one celebrated case the fear was stated to be immediately allayed by the consideration that a large and relatively cheap supply of nitrogenous fertilizer can be obtained from the atmosphere. Incidentally, I have to-day reminded you that scorching sunshine producing the same effect may also increase the supply of wheat. We have also seen how in large areas successful wheat production is prevented by rust and other plant diseases, and I have shown how the scientist appears to be overcoming this serious hindrance to profitable wheat production. Lack of moisture is another of these serious hindrances; and I have indicated how the engineer with his schemes of irrigation, and the agriculturist by conserving soil moisture, and the botanist by providing varieties which will thrive on an exceedingly small rainfall, all have a hand in the work. In short, how, by providing varieties, each one in the highest degree suitable for a given environment, and by providing environments each one optimum for given varieties, wheat growing may be made more profitable in existing wheat fields, and possible as a commercial proposition in enormous areas yet untilled. If the world's yield per acre were large the optimist had need be careful in his prophecies; but it is small, so even the pessimist may prophesy "smooth things" as to the future of wheat production when he contemplates the work in progress. The problem is not how to produce a quantity of wheat sufficient for the world's requirements, but how to do it profitably at the low prices which have been current for years.

I cannot conceive reasons for anxiety in this matter. An increase of 20 per cent., or even 40 per cent. in the average yield per acre, may well be brought about by methods I have indicated; it may become possible to grow wheat profitably on large new areas at current prices; it certainly can be done if those prices advance, so that as regards the production of wheat in the world I am an optimist, and I invite you all to be so, too, not only on that point, but also as to the prospects of wheat production in the tropics.

RECENT WORK IN AUSTRALIA ON THE IMPROVEMENT OF WHEAT.

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At the meeting of the International Congress of Tropical Agriculture, held at Brussels in 1910, two papers were read dealing with wheat improvement in Australia, the one entitled "Work Done in the Testing of Wheat and Flour in New South Wales," and the other, "The Work of the late W. J. Farrer."

In the present contribution it is proposed to review shortly the work done in the different States of the Commonwealth, and particularly during the past four or five years, towards the improvement of wheat, both by individual workers and as a result of departmental action.

As was pointed out in the first of the papers referred to above, the first concerted official action in the direction of studying and improving locally grown wheats was made in 1890, when an Interstate Conference was called to deal specifically with the question of combating rust, which was at that time very prevalent in all the States. In South Australia alone it was estimated that the damage due to this cause in 1899 amounted to £1,500,000.

The result of these Conferences, at which the Agricultural Departments of all the States were represented, was to give an impetus to the systematic study of the wheat plant, with the special object of improving the grain itself, and the methods of soil treatment and crop production. Wheat-breeding stations were established by the various State Departments and systematic experiments were carried out at the farms and stations under Government control, in order to determine the best varieties for different districts, the most suitable manures, the best treatment of the soil, methods of combating disease, etc.

Farmers were supplied with seed wheat, pure and true to name, advised as to their special requirements, and encouraged to experiment on their own account.

The present paper will be confined to a review of the work done in the improvement of the grain itself, either by selection from types already established, or by the creation of new varieties by cross-fertilization.

Characteristics Specially Sought for in Improved Varieties.

The specific points to which attention has been more particularly directed in the production of improved types of wheat have been the following:—

(1) Immunity against rust and other diseases.
(2) Prolificness.
(3) Drought resistance.
(4) Improvement of milling qualities.
(5) Creation of wheats for hay.
(6) Creation of wheats for different districts.

As the conditions of wheat growing in Australia differ in many material points from those prevailing in other countries, most of the above terms possess a significance different from that which attaches to them elsewhere.

It must also be borne in mind that wheats which are pre-eminent locally on account of special characteristics are often failures, even as regards such characteristics, when grown abroad, and *vice versâ*.

The following short notes on the significance of the above terms as applied to Australian conditions may assist in a better understanding of the problems which confront local wheat growers.

Rust Resistance.

The qualities which confer rust resistance locally are by no means identical with those which are required in other countries. The disease itself exhibits certain characteristics which differentiate it from European or American rusts. Mr. D. McAlpine, Pathologist to the Department of Agriculture, Victoria, who is the Australian authority on the subject, finds that of the three kinds of rust which attack the wheat plant, namely, *Puccinia graminis*, or black rust (summer), *P. triticina*, or brown rust (spring), and *P. glumarum*, or yellow rust (spring), the only one that is destructive in Australia is *P. graminis;* of the others, *P. glumarum* does not occur in Australia, and *P. triticina* does little or no damage.

Mr. McAlpine has further shown that the life history of the black rust in Australia differs from its life history in Europe and America. A notable instance is the fact established by him that the barberry, which is said to act as intermediary host for this fungus in Europe, does not function in this capacity in Australia.

Prolificness.

In discussing the question of prolificness it is important to remember that this term also possesses a significance very different to that which it has in Europe.

Harvests of fifty to sixty bushels to the acre are unknown on the Australian continent. The highest individual yield of which I can find any record as being obtained from a reasonable area is one of forty-three bushels given by a new Victorian variety, Commonwealth (*see* p. 32).

The average yields per acre in bushels for the past five harvests in the individual States are as follows:—

	1908-9	1909-10	1910-11	1911-12	1912-13
New South Wales	11·11	14·34	13·11	10·54	14·6
Victoria	13·12	13·72	14·52	9·65	12·6
South Australia	11·45	13·26	11·57	9·29	10·3
Western Australia	8·63	12·48	10·14	7·12	11·6
Queensland	14·87	13·41	9·58	6·64	15·8
Tasmania	24·08	21·41	21·45	17·73	25·0
Commonwealth	11·89	13·73	12·90	9·64	12·5

It is to be noted that the Australian harvest is gathered between November and January, so that the figures for 1908-1909 give the harvest of November or December, 1908, and January, 1909, and represent the grain available for 1909.

Drought Resistance.

The characteristics to be looked for in wheats for dry districts are summarized as follows by Mr. McAlpine, who has made a special and extended study of the wheats suitable to the so-called Mallee district of Victoria: "They must be early maturing to escape the hot winds, drought resisting, holding the grain well (since the grain must be dead ripe for harvesting with the stripper). They must, in addition, be good milling wheats, prolific, and fairly rust resistant."

Milling Quality.

Even with regard to the requirements of a good milling wheat there is a difference between Australian conditions and those obtaining elsewhere. In the first place, the Australian miller produces practically only one grade of flour—straight grade. Grades such as bakers', patents, households, etc., are hardly known, and only a small proportion of flour is exported. It is true that in the last few years an export flour trade is establishing itself, but the trade is not yet sufficiently extensive to modify existing methods to any extent. Moreover, the Australian miller deals only with locally grown wheats which are fairly uniform in character, so that blending as understood in other countries is unknown.

The only modifications consist in the production of more or less offal, according to the state of the market.

Consequently the characteristics of a wheat to be acceptable to the Australian miller are that it shall not differ greatly from the prevalent type, and that it shall yield a good quantity of straight grade flour of good colour and baking quality.

Work done in the Improvement of Wheats in the different States.

(1) New South Wales.

Departmental Action.

Wheat experiments are conducted at Cowra (the headquarters for wheat breeding), Hawkesbury Agricultural College (representing the coastal districts), Wagga (representing the Riverina, the principal wheat producing district of the State), Bathurst (western Tablelands), Glen Innes (northern Tablelands), Nyngan and Coonamble (dry western country), and Yanco (under irrigation).

It will thus be seen that the varying conditions as to climate, rainfall, etc., are represented at the different stations. At these stations the work includes: —

(*a*) Pedigree plots of the main varieties grown on the farm.

(*b*) Cross-bred varieties in course of fixation for local conditions.

(*c*) Seed variety trials, including standard varieties, newly introduced wheats, and samples sent for identification.

(*d*) Stud bulk plots to provide seed for planting the

(*e*) Farm areas, which in their turn supply seed wheat to the farmers.

In addition to the above colleges and farms there are seven or eight more, at all of which (except those specially established for viticulture, dairying, etc.) wheat growing is carried on.

At Cowra, where the wheat breeding is carried on under the direction of Mr. J. T. Pridham (Mr. Farrer's successor), the principal work now being done is the cross-breeding and selection of wheats for special purposes and different districts. Mr. Pridham was an assistant to Mr. Farrer for three years, and has been in his present position of plant breeder since 1911.

During the past season he has rejected a large number of crosses of inferior value, and has paid more attention to selection from existing crosses than to the creation of new ones.

Attempts to secure varieties which are immune from bunt have been discontinued, as it was found that though highly resistant varieties had been produced, complete immunity was never secured, and it has been decided to rely on pickling seed-wheat, which has been found to be an absolutely reliable preventive. Mr. Pridham is of the opinion that with systematic selection plots and the use of clean machinery the farmer will be able to dispense with even this precaution. The elimination of the above work has made it possible to extend the area devoted to selections from cross-breds. Fewer new crosses are made, but the number of selections from each cross has been increased.

Selections are also made from field crops, for although their pedigrees are unknown, they often include useful material. These new wheats are presumably the result of natural cross-fertilization, a phenomenon which Mr. Pridham thinks occurs more frequently than is generally supposed.

With regard to drought resistant wheats, several of the new varieties are extremely promising. It cannot, however, be said of any of them that they are of such general value as Federation. Among these Mr. Pridham regards Sunset as the most promising. It is not, strictly speaking, a new wheat, as it is one of Mr. Farrer's original crosses, and had been rejected on account of its low flour strength. It is, however, likely to prove a very valuable variety, as it matures very quickly and possesses other characteristics which render it admirably suited to dry country conditions. It is being distributed this season. It is a cross between a sport from Blount's Lambrigg and a cross between White Fife and Summer Club. It is one of the earliest ripening kinds and amongst the most prolific in dry districts.

Other new wheats which are being distributed this season are: —

Bomen, one of whose parents is Red Potocka, and the other a cross-bred wheat containing Fife and Indian blood. It was first made in 1901 and proved bunt resistant. It ripens a little later than Federation, is a rather weak flour, prolific variety with good straw.

Canberra, a cross between Federation and Volga barley (a two-row sort contained as an impurity in a sample of wheat received from Russia). Canberra is an early ripening prolific wheat, its defects being that it is rather weak in the straw and has a slight tendency to shell. It yields a high percentage of flour of first-rate colour and good strength.

Nardoo is another promising cross containing Fife and White Naples amongst its parentage. It is a smut resistant variety and a particularly promising hay wheat, though good for grain also, yielding a flour of medium strength.

At the other farms the wheats produced at Cowra are tested for their suitability for different districts and grown in the variety trial plots. The ones that prove valuable are grown on a larger scale in the stud plots and distributed to farmers.

The following list, which gives the varieties recommended by the Department for the present season's sowing (1914-15), represents the final stage of the Department's action in this direction. The wheats marked with an asterisk are Farrer wheats:—

WHEATS RECOMMENDED FOR CULTIVATION IN THE DIFFERENT DISTRICTS OF NEW SOUTH WALES.

A.—*Dual Purpose Wheats.*

Recommended for both Grain and Hay.

Variety	Period of Sowing	Districts
Bobs *	Mid-season and late ...	Central tableland; central-western slopes
Cleveland * ...	Early and mid-season ...	Central tableland; cooler portions of north-western slopes, central-western slopes, and south-western slopes
Comeback * ...	Late	South-western slopes and Riverina
,,	Mid-season and late ...	Central-western slopes; western plains
Firbank * ...	Mid-season and late ...	Central-western slopes; western plains
Florence * ...	Mid-season and late ...	Central-western slopes; south-western slopes and Riverina; north-western slopes; central tableland; northern tableland; western plains
Haynes Blue-stem	Very early	Northern tableland
Marshall's No. 3	Early	South-western slopes and Riverina
,,	Early and mid-season ...	Central tableland; central-western slopes; north-western slopes
Rymer * ...	Mid-season	Central tableland
,,	Early and mid-season ...	South-western slopes and Riverina; central-western slopes; north-western slopes
Thew * ...	Mid-season and late ...	Northern tableland; central-western slopes
Warren * ...	Early, mid-season and late	Coastal
,,	Mid-season	Northern tableland; central-western slopes; north-western slopes; western plains
Yandilla King *...	Early	South-western slopes and Riverina
,,	Early and mid-season ...	Central tableland; north-western slopes; central-western slopes

B.—*Wheats for Grain only.*

Not recommended for Hay.

Variety	Period of Sowing	Districts
Bunyip * ...	Mid-season and late ...	South-western slopes and Riverina; central-western slopes
,,	Late	North-western slopes; western plains
Federation * ...	Mid-season	Central tableland; south-western slopes and Riverina; central-western slopes; north-western slopes

C.—*Wheats for Hay only.*

Not recommended for Grain.

Variety	Period of Sowing	Districts
Firbank * ...	Mid-season and late ...	South-western slopes and Riverina; north-western slopes
Huguenot ...	Early, mid-season and late	Coastal
John Brown * ...	Early, mid-season and late	Coastal
Steinwedel ...	Early and mid-season ...	Western plains; central-western slopes and drier portions of south-western slopes and Riverina
Thew * ...	Mid-season and late ...	Coastal; south-western slopes and Riverina; north-western slopes
Zealand ...	Early	Central tableland; south-western slopes and Riverina; central-western slopes

D.—*Wheats suitable for Green Feed and Soiling.*

Variety	Period of Sowing	Districts
John Brown* ...	Early and mid-season ...	Coastal
Huguenot ...	Early and mid-season ...	Coastal
Thew*... ...	Early, mid-season and late	Coastal; northern tableland; north-western slopes
Florence * ...	Early, mid-season and late	Coastal

E.—*Wheats for further trial.*

Variety	Period of Sowing	Districts
Cedar * ...	**Early and mid-season** ...	**North-western slopes**
Sunset * ...	**Late**	**Western plains**
Bomen * ...	**Mid-season**	**Central-western slopes; south-western slopes and Riverina; north-western slopes**
Genoa * ...	**Early and mid-season** ...	**Northern tableland**
Canberra * ...	**Mid-season and late** ...	**Central-western slopes; south-western slopes and Riverina**
Nardoo * ...	**Mid-season**	**Central tableland; northern tableland; north-western slopes**

F.—*Wheats to be Grown under Irrigation.*

In experiments carried out by the Department, the following wheats have given the best results when grown under irrigation for hay and green fodder:—

(1) Zealand.
(2) Marshall's No. 3.
(3) Florence (late sowing).

It will be noticed that of the twenty-three separate varieties recommended no less than eighteen are Farrer wheats.

Another way in which the New South Wales Department encourages the study of wheat improvement, and, incidentally, the improvement of other crops, is by means of Farmers' Experiment Plots. These were introduced by Mr. G. Valder (Under-Secretary and Director of Agriculture) some years ago. As far as wheat is concerned, these include variety trials and manure experiments carried out by the farmers themselves under the supervision of an officer of the Department. The scheme has worked admirably in encouraging farmers to take an interest in improved methods of cultivation and in selecting the most suitable varieties of crops, and particularly in bringing them into close touch with the Department. These plots are now under the direction of Mr. Hugh Ross, Chief Inspector of Agriculture.

No better proof could be afforded of the value of these plots as object lessons to farmers, and as factors in encouraging improved methods of cultivation, than a comparison of the average bushel yields of the experiment plots devoted to wheat with those of farmers working their land under ordinary conditions.

The following table shows the average annual yield per acre for the State (New South Wales) for the past five years, together with the yields obtained from the Farmers' Experiment Plots.

Average yield per acre in bushels

	1909-10	1910-11	1911-12	1912-13	1913-14
New South Wales	14·3	13·1	10·5	14·6	12·0
Farmers' Experiment Plots ...	24·0	18·75	20·25	24·0	21·0

It is to be noted that the usual size of these plots is 10 acres, only a few being below this area and others running up to 25 acres, and that the increased yields are due to improved farming, such as selection of suitable seed, proper manuring, and particularly fallowing with subsequent cultivation to conserve moisture.

The Agricultural Bureau system which has been introduced recently, and which originated in South Australia (*see* p. 37) must also be mentioned as one of the means by which the farmer is encouraged by the Department to improve his working conditions, and one which assists incidentally in wheat improvement. Some of these Bureaus have instituted what are known as "Seed-wheat growing competitions," which also originated in South Australia. These competitions extend over a number of years, the seed used each year being hand selected from the plot of the preceding year. The area is five acres; the ground must be clean or after long fallow, the seed graded and of a variety selected by the Department. The standing crop is cleaned as far as possible by hand-picking of wild oats, strange heads, etc. The award is made according to a scale of marks given for yield, purity of type, freedom from disease, bushel-weight, and general appearance. This scheme offers a strong incentive to the farmer to improve the quality of his seed wheat, and helps him to do so by systematic methods.

The selection of seed to raise "stud plots" for the coming season by individual farmers, as distinguished from the above-mentioned bureau scheme, is also encouraged by the Department.

The milling of wheats on a small mill and the testing of flour has been carried on in New South Wales since 1885. This has also been a factor in the improvement of wheat, in that it has enabled the breeder and grower to avoid the propagation of inferior grain and to improve local wheats in respect to milling excellence. The Department is also represented on the Grain Trade Section of the Sydney Chamber of Commerce, part of the activity of which body is to strike the standard of quality for shipping (the F.A.Q., or Fair Average Quality standard).

For many years the Department's mill has been utilized for the purpose of awarding the prizes in the wheat section of the Royal Agricultural Society's Show, the prizes being finally awarded to those wheats which give the best milling results.

(2) Victoria.

Departmental Action.

Systematic work in the improvement of wheats by selection, combined with cross breeding, is carried out at the Government Experiment Farms and Stations at Dookie, Longernong, Rutherglen, Wyuna, and more recently at Werribee Research Station. Standard varieties are also grown for seed purposes in "stud plots" for distribution as seed wheat to farmers. An experimental flour mill is in operation on which new varieties can be tested for their milling qualities, and the flour tested and baked into loaves. This is under the charge of Mr. A. E. Richardson, Superintendent of Agriculture. The mill is also made use of in judging the wheats competing at the Melbourne Royal Agricultural Show.

The work at Dookie has been the most prolific of results in the production of improved varieties, and a short description of some of the wheats created by Mr. Pye will serve to show the nature of the work accomplished.

Mr. Hugh Pye, now Principal of Dookie Agricultural College, Victoria, was among the first to take up the systematic study of wheat with a view to its improvement.

Mr. Pye was associated with Mr. Farrer since 1888, when the work of this investigator first came under his notice. They worked in co-operation, since that time exchanging new varieties and ideas. At first Mr. Pye's work was chiefly confined to perfecting Mr. Farrer's wheats and selecting them to suit Victorian conditions. Most of the Federation wheat now grown in Victoria is from the original cross. It developed somewhat differently from the same wheat grown in New South Wales, and is a specially prolific strain.

In his most recent report (*vide* Report of Principal, Dookie Agricultural College for 1913-14) Mr. Pye laments the fact that he had been handicapped in the early days by not being able to avail himself of the services of a testing mill, so that he was unable to breed for milling excellence, and had to devote himself more particularly to increasing prolificness in conjunction with other qualities. Now that a small testing mill is in operation he has the results of twenty years' work to test.

How well he has succeeded in producing good yielding wheats is shown in the following short notes on some of his more successful creations.

Improved Steinwedel was the first new wheat to be distributed for general cultivation. It is a cross between Steinwedel and Purple Straw, two weak-flour wheats which were very popular all over Australia at that time. The cross proved to be a drought-resistant, prolific, early mid-season variety, and had the merit of holding its grain well. The original Steinwedel, though one of the best drought-resistant wheats we have, has the defect of shelling badly. This is a very serious drawback in Australia, where the almost universal use of the stripper requires the wheat to be dead-ripe before harvesting. Improved Steinwedel is still largely grown in Victoria.

Warden was the second variety introduced by Mr. Pye. Its pedigree is (Quartz × Ward's White) × Red Bordeaux. This variety was specially selected for its hay-producing qualities, and is still the most popular hay wheat in Victoria. It took the first prize at the last Melbourne Agricultural Show for wheaten hay.

In addition to its qualities as a hay wheat, it is a prolific, drought-resisting variety, and has done well in the other States. In the drought year of 1902 (when the average yield per acre for the Commonwealth was 2·4 bushels), Warden was the only variety that returned over 10 bushels.

College Purple and Wallace are other popular cross-breds, the latter being specially suited to the cooler districts.

Of Mr. Pye's more recent creations, the following are particularly promising:—

Commonwealth is a cross between Federation and (Queen's Jubilee × Australian Talavera). In his Annual Report for Dookie, July 31, 1913, Mr. Pye reports that this wheat has given excellent results in South Australia and New South Wales, as well as in Victoria. Yields as high as 43 bushels to the acre have been reported, and in several instances it has beaten Federation by 8 bushels. In a dry district in South Australia, where other varieties yielded only 8 to 9 bushels per acre, this wheat gave 15 bushels.

Currawa, a cross between Little Club and (Cretan [a durum] × Northern Champion) is another variety recently distributed. In the first year of its distribution it won first prize in a crop competition. Yields of 30 bushels to the acre and over are common. This season the highest yield recorded is 42 bushels in the north-east of Victoria.

Major is a Federation × Wallace (see above) cross, and is to be distributed next season, a bushel being sent to each of the agricultural societies for distribution to selected farmers who report on its behaviour in the field. It is a weak-flour variety, and has been twelve years under observation.

Yandilla × Red Bordeaux is another very promising variety, which will be distributed in the same way the season after next. It has given very high yields in the farm plots for several seasons. This year it yielded in the farm plots at the rate of 47 bushels to the acre.

Moira is a weak-flour wheat of high promise as a prolific yielder.

(3) South Australia.

South Australia was the first of the States to undertake the systematic improvement of wheats, and the first Australian wheat breeders belong to this State.

In 1881 the late Dr. Schomburg, Director of the Botanic Gardens, Adelaide, supplied a few farmers in South Australia with samples of Du Toits, a variety of wheat grown in South Africa. One of these farmers, Mr. Ward (now resident at Port Pirie), observed a single rust-free plant in a crop that was otherwise eaten up with rust. From this plant was produced the wheat known as Ward's Rust-proof, or Ward's Prolific, a variety which has probably played a more important part than any other single variety in the improvement of wheat in Australia. For Ward's Prolific is not only a rust-resistant and highly prolific variety, thus enabling many farmers to carry on wheat growing at a time when the prevalence of rust threatened to destroy the industry, but it is the parent of all the principal varieties that made wheat growing profitable in South Australia, many of which have proved of even greater value than the parent wheat, and are strong favourites in the other States.

Even more successful as a wheat breeder was Mr. Richard Marshall, who suffered severely from the depredation of rust and other cereal diseases. He set himself to study the disease, and systematically experimented with a large number of varieties obtained from different parts of the world, and by cross breeding and selection succeeded in producing a considerable number of varieties which completely replaced the wheats hitherto in cultivation.

Some of the best-known varieties we owe to this investigator are Marshall's No. 3, Marshall's Prolific, Silver King and Majestic, and the great popularity of these wheats affords ample testimony to his success.

A new era may be said to have been introduced in South Australian wheat growing by these creations of Mr. Marshall, and the older varieties of the Purple Straw, Tuscan, and Lammas type almost disappeared to make place for wheats with harder grain and stiffer straw.

Moreover, their cultivation enabled the farmer to compete with some measure of success against the ravages of rust. Their high yielding power helped to make them popular favourites from the start.

Of the wheats we owe to Mr. Marshall, Marshall's No. 3, Silver King, and Majestic (all extensively grown all over Australia) are derived from Ward's Prolific, being either selected sports from that variety or cross breds.

Yandilla King, another very favourite wheat, is a cross between Yandilla (Farrer's) and Silver King (Marshall's), and hence a lineal descendant of Ward's Prolific. It will be seen what an immense debt Australian wheat growers are under to the two South Australian farmers, Messrs. Ward and Marshall. Other notable varieties obtained by selection from Ward's wheat are Gluyas, Carmichael's Eclipse, and Budd's Early, and these have proved to be of even greater value than the original.

Probably the most extensively cultivated of all is the selection known as Steinwedel, named after a farmer in Balaklava, South Australia, who originated it. This wheat is an extremely prolific and drought-resistant one, and has been for many years by far the most popular grain-wheat for the drier districts. It is still one of the few non-Farrer wheats recommended for cultivation by the New South Wales Department, though it is now giving place to stronger flour varieties and to wheats less liable to shell.

Other South Australian wheat breeders who devoted their energy to the production of improved varieties suitable to South Australian conditions are Mr. Inglis, who is the creator of the rust-resistant variety that bears his name, and Mr. Leak, the originator of another "rust-proof wheat." Both these wheats are still widely grown.

These are the principal varieties we owe to South Australia, and before Mr. Farrer's wheats were created these wheats were grown practically all over Australia. It is no disparagement to them that they are being gradually replaced by varieties which have been more systematically and scientifically bred for special purposes. Many of Farrer's crosses are descendants of one or other of these wheats, and the names of Ward and Marshall are entitled to a high place in the history of the development of wheat in Australia.

Departmental Action.

Systematic attempts to improve wheats have been carried on by the South Australian Department for many years past. The most complete scheme is that introduced by Professor A. J. Perkins, Principal of Roseworthy Agricultural College. Professor Perkins bases his method on the assumption that selection, to be effective, must be continuous and uninterrupted. The broad principle underlying the method is that the best ears are selected from the "selection plots," and are used for the following season's selection plot. The process thus continues indefinitely and automatically, those ears possessing in the highest degree the qualities sought for being alone selected for further propagation in the selection plots. These plots have now been in existence since 1904, so that with some of the original wheats the ninth consecutive selection has been reached. Professor Perkins has very kindly supplied the subjoined description, which will make his method readily understood:—

"We start with a limited number of good ears selected from well-grown plants in a standing crop, let us say King's White. The immediate progeny of these ears, with the exception of the best picked out from them in the following season, I call King's White (first selection). The best ears picked from the best plants become King's White (second selection), and so on indefinitely, the very best ears always becoming one selection in advance of their immediate parents. At the present time we have reached our ninth selection with some of the earliest wheats handled.

"In any given year the picked ears are sown in what I term 'Selection Plots,' *i.e.*, in rows 24 in. apart, each grain being dibbled in one link apart. Each ear is maintained separate under a number or letter, so that I always have several strains of the same variety, many of which are discarded in the course of time if they do not come up to expectations. In the same way all our wheats are strictly pedigreed in that I can trace them all back, strain by strain, to the individual original selections.

"In picking out the best ears attention is paid to the usual points: (1) The plants must be thoroughly satisfactory, well grown, stooling normally, and not lodged in any way. (2) The largest and best-formed ears are roughly picked in the field from the selection plots, and are subsequently handled in the laboratory. (3) As much as possible we give preference to perfect ears, *i.e.*, those carrying no empty shells. (4) Ears are measured individually and the number of spikelets counted; a record of this is kept throughout; only those most satisfactory in this direction are retained. (5) The ears are hand-threshed, and the grain examined and counted; the best again are retained. (6) Finally, the grain of individual ears is always hand-graded before sowing.

"After picking out the best heads for next year's selection plots we run a stripper over the remaining plants, the grain from which goes into what I have called 'Seed Plots,' extending over ½ acre, 1 acre, or even at times 2 or 3 acres, according to the area occupied by individual varieties in the selection plots. In the year following these seed plots supply our farm seed; and in the year after that the grain is available for seed to outsiders.

"By these means our farm seed supply is constantly being renewed by more recent selections. The result has been most satisfactory; all our wheat is sold for seed purposes, and we are never in a position to meet all demands The seed has gone all over Australia, and varieties which have been grown without change on the farm for between seventeen and eighteen years are still some of the best on the farm."

There is also a wheat research station at Parafield. At this station a large and constantly increasing number of cross-bred wheats are made and kept under observation in what are known as "Cross-bred Plots." Last season sixty-eight new crosses were made. In addition to this are the "Breeding Plots," in which hand-selected seed of local and foreign wheats are grown in small plots and made use of for crossing purposes.

Mention has just been made of the nature of the work carried out at Roseworthy Agricultural College. This institution deserves mention as being the first of its kind in Australia, being opened in 1882. In addition to the selection plots already described by the Principal, the College encourages wheat cultivation by carrying out experiments in improved methods of cultivation and in the use of manures.

Other departmental farms which are particularly devoted to wheat are (besides Parafield) Kybobolite, Loxton and Veitch's Well, and Turretfield. The Agricultural Bureau system, which originated in South Australia and has been introduced into New South Wales and referred to above, has also been an important factor in the improvement of wheat. The Bureau consists of a central advisory body with branches in country districts where meetings are held at regular intervals, papers read, ideas exchanged, and discussions held. Officers of the Department attend these meetings and discuss their special lines of work with the farmers, and the system provides an admirable opportunity for keeping farmers in touch with the Department.

(4) Western Australia.

In this State until recent years the most prominent wheat-breeder who sought to improve wheat by cross-fertilization was Mr. G. F. Berthoud. He was also in correspondence with Mr. Farrer, and in the earlier days did a great deal of work in the selection of this investigator's wheats and in acclimatizing them both in New South Wales and in Western Australia. Mr. Berthoud, after leaving New South Wales, started wheat experiment plots at Hamel, in Western Australia, about fourteen years ago, where he worked on the selection and cross-breeding of wheats, both his own and Mr. Farrer's. The outcome was the establishment of a State Experiment Farm at Hamel under Mr. Berthoud's direction.

The district was, however, found to be unsuitable for successful wheat growing, the season being late and wet, and Mr. Berthoud abandoned his experiments.

He was successful in producing several new and valuable varieties of grain which are still popular in Western Australia, the best known of which are:—

Alpha and Cross-bred No. 73.—These wheats are of the same parentage, namely, crosses between Steinwedel and King's Jubilee, and are similar types of grain. They are early wheats, specially adapted to the drier districts.

Zealand is another very valuable variety which we owe to Mr. Berthoud. It was originally imported from France by him in 1888, and grown in the Corowa district of New South Wales. It is essentially a hay-wheat, and has held the position of first favourite for hay in New South Wales for many years, and is still the most reliable hay-wheat we possess for the Riverina and South-western and Western Slopes and Central Tableland. It is not a good variety for grain, the flour being of low colour.

Of the other more commonly grown varieties in Western Australia are:—

Lott's or Gregson's.—This belongs to the English Square Head type, and originated with a Mr. Gregson, of York, Western Australia, from a single selected ear. A neighbour, Mr. Lott, was also instrumental in distributing it, so that it is known under both names. It is one of the most prolific of late mid-season soft wheats, and in Western Australia rivals Federation in this respect.

Penny's is another selection from Square Head wheat, and is also the produce of a single ear. It originated with Mr. Penny, of Green Hills, Western Australia, and is a similar grain to Lott's. It also is very popular in Western Australia.

Mr. Joseph Correll, of the Arthur River, Western Australia, who has made a close study of wheat for the past thirty-nine years, has recently succeeded in raising several new varieties, some of which are already deservedly popular and increasing in public estimation, as well as several others which Mr. Correll expects will prove even more satisfactory.

The best known of these outside Western Australia is Le Huguenot.

This variety originated from a single plant with two beardless heads in a crop of Medeah (a bearded wheat of the Macaroni or Durum type). This plant was harvested separately and sown in the following season, 1898, and has now been fixed for some years. This variety appears to be the result of accidental cross-fertilization. It is particularly valuable as a hay-wheat, as it possesses all the qualities of the best of the Durum wheats, and has the advantage of being beardless. It is one of the varieties recommended for cultivation for this purpose in the coastal districts of New South Wales. It is also a good grain producer, but it is as an improved hay-wheat that Mr. Correll created it, and it now rivals Baroota, the principal wheat grown for hay in Western Australia.

Mr. Correll has also been successful in fixing a number of promising varieties by the same process of the selection of single plants, apparently produced by natural cross-fertilization. Of these Correll's No. 5 is among the best of the early or mid-season varieties. He has two varieties with solid straws and beardless, of similar parentage to Le Huguenot, which he will shortly distribute, and which he considers will be even more generally useful than Le Huguenot, in that they tiller better, hold in the ground better when ripe, and can consequently be better stripped. They are more readily threshed, and produce better and more abundant grain. These varieties he calls La Rochelle and De Conde, and they appear to be the result of natural cross-fertilization between Medeah and a wheat called Hawkes Club, a field of which was growing alongside.

Other varieties (Correll's No. 7 and No. 8) are also hay-wheats and bunt and smut proof and will probably be found to be rust-resistant.

Of the grain wheats, the one which Mr. Correll considers most promising is No. 10, which will shortly be available for distribution. This has long square heads free from tip beards with purple, comparatively short straw and very shotty grain. Mr. Correll's wheats, as will be seen, are all the products of selection of two or three natural crosses, with Medeah for one of the parents.

Among the more recent enthusiasts to take up the matter of wheat breeding in Western Australia is Mr.

W. Catton Grasby, of the Perth Technical College and the *West Australian* newspaper. Mr. Grasby was for some years in communication with Mr. Farrer and Mr. Richard Marshall, of South Australia.

He carried on wheat experimental plots in Western Australia in co-operation with the late Mr. Charles Harper, and since Mr. Harper's death has continued this work alone.

Mr. Grasby has been successful both in selecting special wheats and in cross-breeding. The principal objects at present aimed at by him are the creation of early maturing varieties possessing stiff straw and the production of hay-wheats. In this latter respect very promising results have been obtained by using Le Huguenot as a parent. Tall, well-stooled wheats result, and there is every likelihood of one or more of these wheats taking the place of Baroota, the present favourite. Crosses between Alpha (Berthoud's) and Federation (Farrer's), and also between Federation and Rerraf (two Farrer wheats) give considerable promise, being notably early maturing varieties and escaping mildew, which did a great deal of damage in Western Australia last season. Some of these crosses will be ready for distribution in a couple of years' time.

Departmental Action.

Largely through the instrumentality of Mr. Grasby, the Education Department has introduced wheat growing as a subject for nature study in schools. Mr. Grasby has placed at the disposal of the Department the produce of his own experiment plots, including a number of cross-bred varieties of his own creation.

It is anticipated that the work will prove of great commercial value to the State, although the plots are intended primarily to be educational.

During recent years a small wheat-testing mill has been installed which will enable new crosses to be tested for their milling qualities, as was done by Mr. Farrer, and so prevent the waste of time in cultivating varieties which later are found to be useless on account of their poor milling quality. An interesting investigation has been recently carried out by Mr. E. A. Mann, the Government Analyst (who is in charge of the testing mill), in conjunction with Mr. Grasby, on the effect of manuring on the milling quality of the wheat. The results obtained would seem to indicate that the addition of potash and, in a lesser degree, of lime to the crop increases both the gluten content and also the water-absorbing power of the flour obtained.

Of the experiment farms under the control of the Department of Agriculture, those at Nangeenen, Chapman, Narrogin, and Merridin are especially devoted to wheat culture.

(5) Queensland.

The Agricultural College at Gatton and the State Farms at Roma, Hermitage, and Gindie are all engaged in wheat culture, the farms at Roma and Hermitage being more particularly devoted to wheat production. At these farms variety tests, manurial trials, and seed-wheat plots are all in operation, and seed-wheat true to type is grown to supply farmers.

The late manager of the Roma State Farm, Mr. R. Soutter, now devotes himself exclusively to work in cross-fertilizing. In all the wheat-growing districts of Queensland farmers' experiment plots have been established, in which variety tests and manurial trials are carried on.

There is also a small model wheat-testing mill in operation under the charge of the chemist, Mr. J. C. Brünnich, on which small parcels of wheat can be milled and the flour tested and baked.

It will thus be seen that Queensland, though not a wheat State, has not neglected to provide facilities for the improvement of this cereal. Of individual wheat breeders who have produced wheats of lasting value I am unable to find any record. The names of Dr. Bancroft, Mr. F. M. Bailey (the Queensland Government Botanist), and Mr. Steiger are well known for their work on wheat diseases (particularly rust) in the late 'seventies and early 'eighties. Dr. Bancroft in particular imported and tested a great variety of wheats from other countries with the object of acclimatizing them to Queensland conditions, especially in regard to their resistance to disease.

From the above it will be apparent that a considerable amount of attention is being devoted to wheat improvement in Australia, and that the several State Departments are fully seized with the importance of the subject and afford ample encouragement to its prosecution.

The subject of wheat improvement in Australia is so large that I am very conscious of not having been able to do full justice to it. Numbers of improved varieties are brought forward from time to time as the result of selection, and names are often given to them in order to distinguish them from the original variety. These, however, do not usually enjoy a lasting vogue, and as it would be invidious to mention one or two without mentioning all, I have confined myself to speaking of those varieties that are well established favourites, or which, being the result of scientific selection or cross-breeding, give promise of playing an important part in the future.

In dealing with a subject in which four or five States are in friendly rivalry, it is not an easy matter to apportion fairly the work done by each, and to avoid giving undue prominence to any particular State or to any special line of work.

I am conscious that New South Wales bulks rather largely in the foregoing paper. If an apology is needed for this, it must be found in the fact that I am personally very much better acquainted with what is being done in this State than in the others. Further, New South Wales really has done more than the other States in the matter of wheat improvement. Apart from Mr. Farrer's work, which every one will admit overshadows that hitherto done by any individual in Australia, and apart from the incentive given locally to wheat improvement by that work, the New South Wales Department has a larger and better equipped organization, a greater number of experiment farms, plots, etc., than is the case with the other States. If I have done any injustice it has been unintentional, and due to ignorance and not to prejudice.

I have received a great deal of valuable information from individual workers in all the States, both as regards their own work and that of others. Of those not specifically referred to in the text, I would like to thank the officers of the New South Wales Department for much information, both given verbally and taken from their writings; to Mr. M. Kahlbaum, manager of the Adelaide Milling Co., one of our highest authorities in Australia on scientific wheat milling; to Mr. H. W. Potts, Principal of the Hawkesbury Agricultural College; and to Mr. J. B. Trivett, Government Statistician for New South Wales, for figures in connection with acre yields.

Appendix.

Possible Extension of Wheat Production in Australia.

On the assumption that a rainfall of 10 in. during the growing season (April to October inclusive) may be regarded as the present limit of profitable wheat production, we have in the four principal wheat-producing States the following areas above that limit:—

New South Wales	163,772 square miles
Victoria	74,616 ,,
South Australia	46,980 ,,
Western Australia	93,500 ,,

The whole of this area is, of course, not suitable for wheat growing. In New South Wales, for example, it is calculated that out of the 105,000,000 acres receiving over 10 in. during the growing season, only about one quarter, or about 26,000,000 acres, can be profitably cultivated for wheat.

At the present time, and for the past ten years, the area harvested for grain has represented about 80 per cent. of the total area under wheat, the remainder being cut for hay and green feed. We must assume that this proportion will continue, so that of this 26,000,000 acres it may be assumed that a little under 21,000,000 acres will be the maximum area harvested for grain. At present only about 3,000,000 acres (3,140,000) are under cultivation for wheat. It is therefore possible even under existing conditions to increase the area of wheat production by over 17,750,000 acres in New South Wales. If the average yield per acre of the past ten years (12·1 bushels) is maintained, this would mean a total harvest of over 252,000,000 bushels, as against the 1912-13 harvest of 32,500,000 bushels, and the estimated one of 36,860,000 for the present season.

Figures for the other States regarding the proportion of the area outside the 10 in. isohyetal during crop growth are not available, as far as I am aware, but we may fairly assume that this proportion is much the same as in New South Wales, and that one quarter of the area given in the preceding table can be made available. We shall then get the following figures for possible acreages and yields:—

	(1) Area with over 10 in. rain during growing season	(2) Area available for wheat growing. One-quarter of column (1)	(3) Area available for grain 80 per cent. of column (2)	(4) Average yield for last 6 years, 1907-8 to 1912-13	(5) Total yield
	Acres	Acres	Acres	Bushels per acre	Bushels
New South Wales ...	104,814,080	26,203,520	20,962,816	12·04	252,392,305
Victoria	47,754,240	11,938,560	9,550,848	11·81	112,795,515
South Australia ...	30,067,200	7,516,800	6,013,440	11·08	66,628,915
Western Australia ...	59,840,000	14,960,000	11,968,000	10·13	121,235,840
Total for four States...	242,475,520	60,618,880	48,495,104	—	553,052,575

The following table gives the area actually under crop and the production for the past two seasons for all the States of the Commonwealth:—

	1912–1913		1913–1914	
	Area under wheat	Production	Area under wheat	Production (estimated)
	Acres	Bushels	Acres	Bushels
New South Wales ...	2,231,514	32,487,336	3,141,316	36,860,000
Victoria	2,085,216	26,223,104	2,565,861	32 936,245
South Australia ...	2,079.633	21,496,216	2,054,364	16,805,945
Western Australia ...	793.096	9,168,594	1 068,553	13,069.000
Queensland	124,963	1,975,505	—	2,053,000
Tasmania	25,226	630,315	—	421,000
Commonwealth ...	7,339,648	91,981,070	—	103,045,190

It is to be noted that the Australian harvest is reaped between November and January. Thus the figures for, say, 1912-13 give the harvest from November, 1912, to January, 1913, and represent the grain available for 1913.

The possible extension of the area under wheat, and the increase of production from the present 103,000,000 bushels for the Commonwealth to about 550,000,000 bushels for the four principal wheat States will be found to be a low estimate when the data on which it is based are examined more closely.

The assumptions are:—

(1) That wheat cannot be grown profitably with less than 10 in. of rain during the period of growth.

(2) That the proportion of land suitable to or available for wheat production is about one-quarter of the total area within this isohyetal.

(3) That the average yields per acre for the past six years will be maintained.

(4) That only four States take part in this expansion.

With regard to (1), it may quite reasonably be expected that improved methods of cultivation and improvements in drought-resisting wheats may make it possible to extend the area of profitable wheat growing into even drier districts than are now considered safe. In addition, there is the possibility of growing wheat in the dry areas under irrigation, a subject that is now being pushed forward energetically in all the States.

A very considerable change has taken place within the last few years in our ideas as to what constitutes a safe rainfall for wheat growing.

In 1904 the late Government Statistician for New South Wales (Sir T. A. Coghlan, now Agent-General for New South Wales in London) placed on the map a "wheat-experience line" which defined the extreme western boundary of profitable wheat growing at the time. Since that time, however, the causes mentioned above—improved methods of cultivation and improved wheats—have caused this line to be extended westwards to such an extent that the present Government Statistician (Mr. J. B. Trivett) has been able to put a new wheat-experience line on a map issued by him in 1912, showing the inclusion of an additional 13,500,000 acres on which wheat is being profitably cultivated.

With regard to (2) the proportion of suitable land, I can only find that this has been estimated with any accuracy in the case of New South Wales. This estimate leaves out of account all the coastal districts and the northern districts where wheat is now grown only for hay. It also excludes the mountainous country and all country which under present conditions is unsuited to wheat.

The late Director of Agriculture for Victoria (Professor Cherry) estimated the area available for wheat production in that State at 28,000,000 acres. If this estimate is correct, the total production of wheat in Victoria would be capable of being increased to 264,500,000 bushels, and that for the four States to over 705,000,000 bushels. The estimate appears, however, to be high, as it assumes that considerably more than half the area receiving 10 in. of rain from April to October is suitable and available for wheat growing.

(3) The average yields per acre for the separate States has been maintained fairly at this level for the past ten or eleven years. We experienced one exceptionally droughty season as late as 1902, when the yield per acre for the Commonwealth was only 2·4 bushels, but the succeeding harvest yielded an average of 13·32 bushels. The average for the past six seasons (1907-08 to 1912-13) is 11·59 bushels. Last harvest (1912-13) yielded an average of 12·5 bushels.

(4) No account is taken of expansion in other States than the four present wheat States. Tasmania is not likely ever to develop to any extent as a wheat producing country; but, on the other hand, Queensland has enormous areas suitable for wheat production, which will undoubtedly be cultivated as the country develops. The Northern Territory is another unknown quantity. Wheat, in common with other crops, has only been experimentally tried, and the Commonwealth Year Book gives the area under cultivation as 2 acres. From the reports of those who have been there, there is no doubt that there is an enormous area, both within and outside the tropics.

where climate and soil are quite suitable for wheat growing, and we are justified in looking forward to a very considerable addition to our wheat growing area when the Territory becomes developed.

Taking all these points into consideration, I feel convinced that the estimate given is a low one, and may be regarded as a quite legitimate forecast of the expansion to be expected under present conditions, and at the present rate of expansion of the industry. For the data on which this estimate is based I am indebted to the Government Statistician (Mr. J. B. Trivett), who has kindly placed all available information at my disposal.

Purely economic considerations have not been taken into account in the foregoing discussion. The continually increased cost of farm operations and labour troubles in connection with harvesting, sowing, etc., have to be reckoned with; further, the present want of railway facilities and the absence of bulk handling are factors which will be particularly discouraging when the question arises of developing such large areas. Bulk handling is a subject that is being much discussed at present, and it would seem to be fairly certain that some system will come into operation within the next few years.

Even with the present expansion the railway authorities find great difficulty in handling the harvest, and some improvement on the present system becomes more and more imperative every year.

L'AMELIORATION DE LA CULTURE DU BLE EN ALGERIE ET EN TUNISIE.

Par Emile Baillaud.

Secrétaire Général de l'Institut Colonial de Marseille.

La production du blé en Algérie-Tunisie est d'environ, 12 millions de quintaux dont les trois quarts sont des blés durs.

Ces chiffres correspondent à une moyenne car les rendements varient considérablement d'année en année suivant les périodes de pluies ou de sècheresse. En outre ces rendements varient également suivant qu'il s'agit des cultures des colons européens où de celles des indigènes. La moyenne obtenue par les indigènes ne dépasse guère trois à quatre quintaux à l'hectare tandis que les Européens obtiennent au moins en général 12 quintaux. Or les quantités obtenues par les indigènes sont beaucoup plus importantes que celles des Européens pour les blés durs tout au moins qui forment la principale partie de la production du blé en Algérie : les blés tendres sont surtout cultivés par les européens. On voit donc le très grand intérêt qu'il y a à améliorer ces rendements.

Cela peut être fait en introduisant les nouvelles méthodes de culture comme celles qui sont comprises dans la dénomination de "Dry-Farming" mais aussi en améliorant les variétés cultivées.

Jusqu'ici les efforts qui ont été fait dans cet ordre d'idée ont porté surtout sur la sélection des variétés locales.

Sous la féconde direction de M. Boeuf d'abord comme chef de la Station Expérimentale de l'Ecole Coloniale d'Agriculture de Tunis puis actuellement comme chef du Service botanique de la Régence, on a appliqué les principes de sélection Svaloff à plusieurs milliers de variété de céréales recueillies dans la région. Un petit nombre de sortes reproduites par voies pédigrées ont été retenues en raison de leur mérite; elles ont été multipliées à la fois dans les Champs de la Station Expérimentale de l'Ecole d'Agriculture et dans deux stations confiées à deux colons de grand mérite MM. Louis Boutet et Faucon et mises à l'essai dans un grand nombre de champs d'expérience réparties dans toute la Tunisie. L'on devait ainsi se rendre compte de leur faculté d'adaptation dans les différents milieux et de la transformation suivant les conditions dans lesquelles elles se trouveraient.

Malheureusement la sècheresse de ces dernières années a pour ainsi dire interrompu cette multiplication et l'on en est simplement encore à la période expérimentale. Cependant M. Boeuf a pu préciser ses méthodes et obtenir des résultats de la plus haute importance au point de vue de leur application et toutes les dispositions sont prises pour commencer en plus grand des reproductions.

En Algérie les essais ont été poursuivis à l'Ecole d'Agriculture de Maison Carrée sous l'experte direction de M. Ducellier et dans un certain nombre de champs d'expérience situés dans les différentes régions de l'Algérie.

Sans s'attacher exactement à l'obtention de semences pures, les principaux colons algériens et tunisiens se sont préoccupés depuis longtemps de l'amélioration des semences et on peut dés maintenant procéder à une première classification des blés d'Algérie Tunisie.

L'Institut Colonial de Marseille s'est adonné tout particulièrement à l'étude de ces blés qui sont un des principaux aliments de la minoterie et de la semoulerie de ce port.

En 1910 il leur a consacré une de ses Expositions spéciales et depuis cette époque il n'a cessé de rechercher de quelle manière il pourrait mieux seconder les travaux de sélection fait en Algérie et en Tunisie et nous donnons ci-dessous une énumération succinte des principaux types sur lesquels a porté jusqu'ici cette enquête.

Les formes de blé algérien, soit durs, soit tendres, sont fort nombreuses et de valeur inégale pour l'agriculteur et le commercant. Sauf la tuzelle de Sidi Bel-Abbès ou blé d'Odessa sans barbes, aucune de ces formes n'est cultivée à un degré de pureté suffisant et les cas où le mélange

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des semences est composé des deux variétés sont rares. On trouve fréquemment cinq ou six variétés bien différentes comme végétation, production, qualité de grain en étudiant les blés sur pied dans un même champ.

Les efforts combinés de l'Institut Colonial de Marseille et du Syndicat des Minotiers et Fabricants de Semoules de Marseille ont conduit à une amélioration de la situation passée en ce sens que les cultivateurs de nos possessions méditerranéennes savent quelle est la plus value qu'ils peuvent retirer de la vente de leurs blés, si elle a lieu de telle manière que le mélange des différentes variétés soit évité, mais cette amélioration ne sera générale que le jour où le commerce des grains algériens et tunisiens sera organisé sur des bases nouvelles et tel qu'il se pratique dans les pays grands exportateurs de blés. Un premier point cependant a été acquis définitivement celui de la répression des fraudes.

Ces travaux préliminaires ont montré la nécessité de s'organiser spécialement pour déterminer, parmi les variétés sélectionnées dans nos Colonies Françaises, celles qui seraient les plus intéressantes au point de vue industriel. A la suite d'enquête effectuée par son Secrétaire Général, M. Emile Baillaud, et des rapports de M. Arnaud, Président de la Chambre Syndicale des Minotiers et Fabricants de Semoules de Marseille et de M. le Professeur Jumelle, l'Institut Colonial a décidé d'adjoindre à ses services un Laboratoire spécialement destiné à l'étude des céréales et plantes féculentes des possessions françaises et muni des machines de meunerie et de rizerie (en réduction) qui permettent de faire l'essai industriel des blés (meunerie, semoulerie, boulangerie) des riz (décortication, blanchissage, glaçage) et des plantes féculentes autres que les céréales (préparation et extraction des amidons, fécules, alcools, etc.).

Les études industrielles faites dans ce Laboratoire seront complétées par la détermination botanique et les analyses chimiques nécessaires. Lorsque ces études auront été entreprises dans les Colonies, ce Laboratoire se bornera à en centraliser les résultats. Lorsque au contraire, les Stations locales manqueront de l'outillage et des éléments nécessaires, le Laboratoire se mettra à leur disposition pour effectuer les études qu'elles lui demanderont; dans tous les cas, la centralisation qu'il exercera permettra à nos diverses Possessions de profiter des résultats obtenus dans chacune d'elles ou à l'Etranger; elle aura ainsi pour but de faire connaître à l'industrie métropolitaine les nouvelles variétés sélectionnées et de permettre la détermination de celles qui seront plus particulièrement intéressantes au point de vue industriel.

Ces travaux contribueront en outre à élucider les problèmes si complexes que se posent la Minoterie, la Rizerie et les industries qui utilisent les plantes à fécules.

Principaux Blés algeriens-tunisiens.

(1) Blés durs.

Adheba.

Variété dominant dans le Sud de l'arrondissement de Sétif vient assez bien dans les terres maigres où il murit de bonne heure. Inférieur au Mahmoudi, au Mohamed-el-Bachir et à l'Adjini au point de vue semoulier.

Adjini.

Epi blanc velu, compact, court, large de 15 à 18 millimètres, long de 5 à 6 centimètres. Rachis découvert d'un côte. Epillets très serré à 4 fleurs, 3 fertiles; glumes fortes, longues: glumelles inférieures munies d'une barbe noire. Grain rougeâtre, gros, court bossu pesant (Ducillier).[1]

Ce blé est réputé comme étant le blé semoulier par excellence.

Ajili.

Epi court à 4 rangs, glumes blanches presque glabres, barbes longues, noires en faisceau effilé. Grains de grosseur moyenne blond ovale légerement bossu. Paille

[1] "Culture et vente des céréales en Algérie," *Bulletin de la Société des Agriculteurs d'Algérie,* 15 août, 1909.

atteignant 1 m. 60 dans les meilleures conditions (Minangoin).[1]

Ce blé qui résiste bien à la rouille est le plus répandu dans les environs de Sfax où il donne un grain très estimé. La Station Expérimentale de l'Ecole Coloniale d'Agriculture de Tunis l'indique comme convenant aux terres sablonneuses légères.

Azizi.

Epi de sept à huit centimètres, glumes à peu près glabres d'un brun foncé rougeatres par place. Barbes brunes, longues, formant un faisceau cylindrique. Son grain est très beau, très recherché par la meunerie. A le défaut de rouiller. Il est cultivé dans le Nord. On le rencontre principalement dans le Centre de Sousse à Kalrouan. A M'Saken les indigènes le vendent comme blé de semences après lui avoir fait subir un triage à la main (Minangoin).

D'après Scofield, cette variété serait originaire de Tunisie et bien quelle soit connue en Algérie, elle n'a pas pris une grande extension.

Béliouni.

Epi rouge, lisse, long, de même largeur de la base au sommet. Epillets rapprochés, 5 fleurs dont 3 ou 4 fertiles; glumes et glumelles fortes, barbes noires très fortes, longues. Grain glacé, jaune, gros (Ducellier).

Cette variété paraît être celle qui est la plus appréciée au point de vue de la rusticité et des rendements.

Après des essais de plusieurs années, beaucoup de colons l'ont adopté dans le département de Constantine comme bon blé semoulier, résistant à la chaleur, ayant une paille moins cassante que celle du Mahmoudi, ce qui est gros avantage pour la moisson et un bon rendement, meilleur que l'Adjini qui pourtant est le blé semoulier par excellence.

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[1] "La culture des céréales en Tunisie," *Bulletin de la Direction de l'Agriculture de la Tunisie*, 1re trimestre, 1908.

Bidi ou Bihedi.

Epi court (4 à 5 centimètres), très trapu, à rachis apparent, légèrement recourbé, gros, blond, clair. Paille atteignant 1 m. 75 à 2 mètres dans les bonnes terres et les meilleures conditions (Minangoin).

Ce blé originaire de Sétif a donné des résultats supérieurs dans les parcelles bien cultivées en Tunisie. La plante qui est vigoureuse semble plutôt se plaire dans les coteaux élevés.

Biskri ou Beskri.

Nom donné dans la région de Téboursouk à un blé qui ressemble beaucoup au Mahoumi.

D'après MM. Perriquet et Nancy qui ont commencé à la cultiver dans la plaine du Krib, il y a quatre ans ce blé est très vigoureux et, devant les résultats obtenus, sa culture s'est étendue chez leurs voisins qui en sort fort satisfaits. Il donnerait en effet de meilleurs rendements que l'Adjini et le Souri précédemment cultivés. La plante est forte et de belle venue, la couleur d'un vert tirant sur le bleu et des feuilles très larges. Si la plante n'a pas souffert dés la maturité, les barbes sont bien noires. Le grain est gros. Il semble résister assez bien à la sècheresse et la verse.

Blé Chalvin.

Ce blé est un blé Pélissier que M. Chalvin cultive à Vesoul-Beniam pour l'obtention de semences. Les colons de la région de Boufarik, Blidah, ont adopté sous son nom la semence qu'ils lui demandent. Il résiste bien à la sècheresse.

Genah-el-khetifa (aile d'hirondelle).

Epi de 8 à 9 centimétres, glumes et barbes d'un beau noir, rachis teinté de noir avec un anneau de même couleur à la naissance de l'épi (Minangoin).

M. Paul Deligne a cultivé ce blé en partant d'un épi trouvé dans un champ en 1903 et il est parvenu à obtenir en 1910 132 quintaux. D'après lui cette espèce semble ne pas craindre les maladies et ne pas être très difficile au point de vue culture.

Ce blé fait très peu de déchets (4 pour cent), poids à l'hectolitre 83 kilos, paille dure et très rigide. Son grain est beau; il est très précoce et résiste par conséquent au siroco. Il est peu sujet à la verse et à la rouille.

Hache ou Hechede.

Epi blanc quelquefois teinté de rose, lisse droit, court, 6 à 7 centimètres de longueur. Epillets peu serrés 3 à 4 fleurs dont 2 à 3 fertiles, glume forte à pointe un peu arrondie; glumelle portant une barbe blanche, fine. Grain rouge, petit court. Paille fine très blanche, peu sensible aux maladies (Ducellier).

M. Ducellier l'indique comme peu sensible aux maladies. Cette variété rustique très répandue dans toute l'Algérie n'est jamais cultivée en grand. On en rencontre quelques épis à Tlencem, Mascara, Tiaret, Bordj bou Arréridj, Batna, Sétif.

Hamira.

Epi carré à six rang de 7 à 9 centimètres; à glumes brunes violacées, à barbes rouges de longueur moyenne et disposées en faisceau cylindrique, le grain est gros, long, à sillon profond. La paille est courte (Minangoin).

Cette variété est cultivée par les Arabes de préférence au Mahmoudi dans le Nord de l'Algérie parque qu'il est moins exigeant que ce dernier, mais étant très sujet à la rouille, il réussit dans les terres qui s'égouttent facilement.

Mahmoudi.

Epi blanc aplati, large de 15 à 18 millimètres velu, long de 5 à 6 centimètres. Epillets très rapprochés, recouvrant très complètement l'axe de l'épi, cinq fleurs dont quatre fertiles; glumes fortes de 14 à 15 millimètres, quelquefois colorées en noir sur la carène; glumelles inférieures longues, prolongées par une forte barbe noire très longue dépassant la somme de l'épi de 15 à 16 centimètres. Grains allongés, très gros, un peu courbés, ambrés, très bel aspect (Ducellier).

Cette variété paraît être la plus appréciée dans le département de Constantine où elle est connue sous le nom de Nab-el-Bel Richi et où elle est souvent cultivée en mélange avec le Béliouni et l'Hamira, dont les grains sont de la même couleur. Elle est adoptée également en Tunisie et dans l'Est du département d'Alger (Aïn-Bessem, Aumale, Thiers et Médéah).

Le type le plus connu au point de vue commercial est celui obtenu par la Compagnie génevoise des colonies suisses de Sétif qui, grâce à la manière dont elle le sélectionne depuis de longues années, est arrivée à lui faire faire prime sur le marché.

Blé de Mahon.

Epi blanc, lisse, long, 8 à 10 centimètres, un peu courbé à la maturité. Epillets secs espacés sur le rachis 4 fleurs dont 2 à 3 fertiles; glumes portant une courte arête carénées à la partie supérieure seulement, glumelles inférieures prolongées par une barbe blanche écartée de l'axe de l'épi qu'elle dépasse de 7 à 8 centimètres, les balles s'entrouvent à la maturité et le grain tombe au moindre coup de vent. Grain jaune pale de bonne qualité surtout dans la plaine de Chéliff. Paille demipleine, blanche, très résistante à la rouille (Ducellier).

L'échantillon sélectionné par l'Ecole d'agriculture algérienne de Maison-Carrée provient d'un sol argilo-siliceux calcaire et a donné un rendement à l'hectare de 14 quintaux avec un poids à l'hectolitre de 80 kilos.

Dur de Médéah.

Epi très coloré, rouge tirant sur le noir, droit, un peu plus mince au sommet. Epillets très rapprochés, 5 fleurs, 3 à 4 fertiles enveloppées par 2 glumes fortes, très carénées, glumelles inférieures fortes prolongées par une arête noire cassante à la maturité, dépassant l'épi de 13 à 15 centimètres. Paille blanche forte résistante à la verse et aux maladies (Ducellier).

Grain bossu, concave du côte du sillon, rappelant un peu celui de certains poulards, riche en gluten.

Ce blé est un des blés durs que Vilmorin cite dans son ouvrage: "Les meilleurs blés" comme susceptibles d'être cultivé en France. D'après lui le blé de Médéah est une forme tout à fait méridionale qui réussit surtout au sud de la Méditerranée. Il y a une quinzaine d'année environ que cette variété est cultivée en Egypte, où elle est particulièrement estimée à cause de la richesse de son grain en gluten.

Mohamed-el-Bachir.

Ce blé sélectionné par le Syndicat Agricole de Sétif et répandu dans la région Nord de Constantine en terres riches et profondes, est un peu plus tardif que le Mahmoudi.

Grain clair allongé, bon semoulier.

Blé Pélissier.

Très voisin du blé de Séville à barbes noires dont il dérive par sélection, appelé encore Hebda. Bel épi carré, gros, long de 8 à 10 centimètres, de coloration variable, plus ou moins velu, suivant les régions. Sur le littoral d'Alger, l'épi devient complètement lisse et blanc, ainsi que ses barbes. Epillets serrés composés de 5 fleurs dont 4 fertiles; glumes très fortes, noirâtres sur la carène; glumelles inférieures munies d'une barbe forte et longue, ordinairement noire. Grain long, glacé, jaune, tirant sur le blanc, très estimé (Ducellier).

Ce blé a pris une grande extension dans le département d'Oran en raison de ses bons rendements. Dans le département d'Alger il est également cultivé depuis quelques années à la suite des essais faits à la Station Botanique de Bouïba où après sélection il a été classé en première ligne par ses rendements et la qualité de son grain.

Ce blé, qui est probablement d'origine espagnole, doit son nom à un cultivateur des environs de Pont des Issers dans la vallée de la Tafna, qui l'a sélectionné.

Réalforte.

Epi de 8 à 9 centimètres absolument carré, à six rangs. Glumes et barbes d'un beau jaune doré. Grains gros, peu allongés (Minangoin).

Ce blé, d'introduction récente dans le Nord de l'Afrique est originaire de Sicile. Cette variété semée en Tunisie dans les environs de Mateur, donne des rendements bien supérieurs à ceux obtenus avec les autres variétés.

Blé rouge de Tlencem.

Epi rouge, lisse, allongé, atteignant dans les bonnes terres 11 à 12 centimètres, ordinairement 8 à 9; aussi large à la base qu'au sommet. Epillets moins rapprochés que dans les autres blés durs à 3 à 4 fleurs dont 2 à 3 fertiles; glumes fortes terminées par une pointe aigue, glumelles inférieures munies d'une forte barbe noire très longue, dépassant le sommet de l'épi de 14 à 15 centimètres. La couleur des barbes varie et devient quelquefois identique à celle des balles. On trouve cette variété à Tlencem, Mercier-Lacombe et dans le Nord du Sersou. Quoique son épi soit très beau, elle n'est pas très cultivée, car elle craint les coups de chaleur et son grain est plus petit que celui des blés durs en général. Cette variété ressemble beaucoup au blé Paris introduit de Grèce il y a quelques années (Ducellier).

Grain mince, pointu, ambré, de bonne qualité.

Blé de Séville à barbes noires.

Epi blanc, glabre ou un peu velu teinté de noir sur les glumes, long de 5 à 6 centimètres droit, un peu effilé à la partie supérieure. Epillets très rapprochés, formés de 3 ou 4 fleurs fertiles; glumes prolongées par une pointe courte de 2 ou 3 millimètres, glumelles inférieures portant une barbe noire dépassant l'épi de 2 à 3 centimètres, écarté de l'axe. Grain allongé, glacé, jaune blanchâtre (Ducellier).

D'après M. Ducellier, cette variété rustique est cultivée dans l'Ouest de l'Algérie, seule ou en mélange. Dans le département d'Oran on la trouve à Ain-Témouchant, dans la vallée de la Tafna, à Tlencem où elle constitue à peu près la moitié des emblavures du blé dur : à Mascara dans la plaine des Eghrus, à Tiaret. Elle est aussi cultivée dans le Sersou, à Aïn Bessem et Bordj bou Arréridj où les indigènes l'appellent Djoul à cause de sa bonne qualité. Elle a été introduite d'Espagne depuis très longtemps.

Sbai ou Souaba-el-Aldjia (doigt ou doigt de l'esclave).

Epi court, 4 à 5 centimètres, glumes blanches, légèrement velues, barbes noires, jaune doré à leur extrémité. Grain jaune, transparent, très gros et très allongé. Ne réussit que dans le Nord ou dans les terres très fertiles (Minangoin).

La Station Expérimentale de l'Ecole C. d'A. de Tunis indique comme lui convenant les plaines à sol argileux frais.

Souri.

Epi long, de 9 à 10 centimètres, glume jaune, dorée, glabres. Barbes très longues de même couleur. Donne une paille blanche, longue, plus estimée que celle de Mahmoudi et de l'Hamira.

Ce blé est cultivé dans le Nord de l'Algérie surtout dans les terres fraiches et riches, il se sème souvent en mélange avec le Mahmoudi et l'Hamira.

D'après M. P. Deligne il a peut-être le défaut d'être un peu exubérant comme végétation, mais cela lui permet mieux de se défendre contre les mauvaises herbes, il résiste bien aux maladies et donne un beau grain. Le rendement est de 12 à 15 quintaux en belle culture, comme déchets moyens que l'on peut facilement réduite au battage, il donne de 4 à 6 pour cent.

(2) Blés tendres.

Allorah.

Blé tendre à épi rouge barbu, introduit très récemment dans la Vallée de la Medjerda.

Blé de Bordeaux ou Blé rouge inversable.

Epi rouge brun, souvent courbé, ressemblant à celui du blé rouge d'Ecosse, mais présentant souvent sur l'axe et sur les glumes une teinte glauque, que n'a jamais celuici. Paille moyenne forte et souple, demi pleine. Grain rouge, gros, assez court, lourd et bien plein (Vilmorin).

Les blés rouges de Bordeaux ont été introduits dans la région de Saïda, mais, d'après M. Van Eyll, ils s'y cultivent peu et, bien que donnant de très bons rendements certaines années ils semblent plus sensibles au froid et surtout au siroco que les Tuzelles de Provence ou les Richelles de Naples. Leur maturité est un peu plus tardive et c'est là aussi un défaut important dans une région où l'hiver est souvent assez rigoureux.

Richelle blanche d'Alger.

Epi blanc, très long, 12 à 13 centimètres, lisse, brillant, faisant le cou d'oie à la maturité. Ce dernier caractère permet de distinguer facilement les champs de Richelle. Epillets bien séparés, régulièrement disposés, trois à quatre fleurs, glumes et glumelles munies d'une courte arête recourbée (Ducellier).

Grain blanc, court, très farineux.

Variété très productive, introduite par le Service Botanique qui a obtenu par sélection la variété désignée ci-dessus cultivée dans la Mitidja, sur le littoral, dans la plaine des Eghrus, à Mascara.

Blé de Rieti.

Epi blanc, glabre brillant, courbé à la maturité. Epillets très éloignés les uns des autres et de plus en plus petits vers le sommet de l'épi; quatre fleurs dont trois fertiles; glumelles inférieures munie d'une barbe noire, disposée comme celle du blé de Mahon. Grain très coloré, presque brun, peu apprécié en Algérie à cause de sa couleur malgré sa richesse en gluten. Paille creuse, faible, peu sensible à la rouille (Ducellier).

Cette variété originaire de l'Italie centrale, est cultivée sur le littoral de l'Algérie, mais elle est encore peu répandue.

Richelle blanche de Naples ou Grano carosella.

Epi blanc assez éffilé, demi-long, souvent courbé, très peu élargi, muni de quelques arêtes courtes vers le sommet. Grain blanc, beau et gros, assez allongé, bien plein, de très belle qualité. Paille très blanche assez haute, abondante. C'est une des variétés les plus faciles à reconnaître. Il n'en est à peu près aucune dont l'épi se rapproche plus complètement par l'aspect de l'épeautre blanche sans barbe (Vilmorin).

M. Van Eyll, qui la cultive dans son domaine de Fenouane aux environs de Saïda, trouve que comme précocité, la Richelle de Naples est supérieure à la Tuzelle de Provence, mais elle semble moins résistante au froid. Elle est également moins riche en gluten. En année favorable, son rendement est supérieur à celui de la Tuzelle et l'idéal serait de semer ces deux sortes en mélange, mais en raison de leur différence d'époque de maturité, la chose n'est pas possible. Il lui semble prudent avant d'accorder une trop grande place à cette variété, d'attendre un acclimatement plus complet.

Tuzelle de Bel-Abbès ou d'Odessa.

Epi rouge irrégulièrement coloré, lisse, brillant, long de 9 à 11 centimètres, plus gros au milieu qu'aux extrémités. Epillets allongés, rapprochés au centre de l'épi, avortés quelque fois à la base, dirigés à droite et à gauche de l'axe de l'épi. Ce caractère permet de distinguer facilement cette variété. Epillets à 6 fleurs dont 4 à 5 fertiles, glumelles inférieures munies au sommet de l'épi d'une arête rouge de 2 ou 3 centimètres. Grain blanc, long, un peu corné à la périphérie. Très bonne qualité commerciale (Ducellier).

Cette variété est très répandue à Bel-Abbès, Mercier-Lacombe, Mascara, Sersou, Tiaret, Bordj bou Arréridj.

M. Ducellier indique que cette variété qui réussit si bien dans la plaine de Sidi Bel Abbés, dans le Sersou aux environs de Tiaret, et aussi dans la région de Sétif où elle donne des blés si remarquables et si appréciés par le commerce, craint sur le littoral d'Alger la rouille et les intempéries. Son grain au lieu d'être d'un blanc uniforme se parsème de graines foncées qui le déprécie. Il n'est donc plus cultivé dans la Mitidja pour cette raison.

Tuzelle barbue ou barbue de Bel-Abbès.

Epi rouge, long de 10 à 12 centimètres, lisse. Epillets à 4 fleurs, 3 fertiles, glumes aristées, glumelles inférieures munies d'une barbe rouge, écartée du rachis. Grain blanc allongé de même qualité que le Mahon. Paille demi pleine, blanche, résistante à la rouille (Ducellier).

Ce blé est surtout cultivé dans le département d'Oran à Bel-Abbès, Mascara et dans le chéliff en mélange avec le blé de Mahon.

En Tunisie il est introduit également depuis quelques années où il paraît préférable à la Tuzelle de Provence (ou d'Oran) comme étant plus résistant aux maladies, moins sujet à la verse, s'égrenant moins et donnant de meilleurs rendements (cette Tuzelle est appelée en Tunisie également Tuzelle barbue d'Oran).

Tuzelle rouge de Provence.

Epi rouge violacé, lisse, long de 9 à 10 centimètres, grêle effilé. Epillets régulièrement disposés à 3 à 4 fleurs, glumes sans arête, glumelles sans barbe sauf au sommet de l'épi où elles sont munies d'une arête d'un ou deux centimètres (Ducellier).

Grain rouge, un peu corné, de bonne qualité.

THE INDIAN CEREAL TRADE.

By Frederick Noël-Paton.

Director-General of Commercial Intelligence, India.

I have been asked to read a paper on the Indian Cereal Trade, and the point to which I wish to give the greatest prominence from the outset is that India only exports about 6 per cent. of her cereals. The rest is wanted for home consumption, and it is not possible to discuss even the export trade without regard to that fact. For an expansion of consumption by 1 per cent. (or a corresponding contraction in yield) would presumably reduce the theoretically exportable surplus by 16 per cent., while the said surplus would disappear altogether if the internal consumption grew by 6⅓ per cent.

The subject given me has many branches and aspects, on any one of which one might write a volume. I can, therefore, only run over them superficially. The population of India is distinguished from that of any European country, not only by its magnitude, but by its diversity in respect of races, and of the customs and diets peculiar to the several tracts. Throughout the greater part of the United Kingdom one rarely finds any food-grain but wheat, oats, and barley in common use, and these are grown at one season, so it is easy to establish the total area covered by them. But in India there are many food-grains—rice, wheat, maize, jowar (*Sorghum vulgare*), bajra (*Pennisetum typhoideum*), ragi (*Eleusine coracana*), and a variety of other secondary millets and grains which there is no time to describe. These cereals, moreover, are grown, one as a rain crop and another as a cold weather crop, while some are grown in both seasons. And the seasons themselves are not by any means in unison throughout India.

These circumstances greatly complicate the preparation of crop returns in India; and another difficulty consists in the smallness and multitude of agricultural holdings. The crops are grown mainly for internal consumption, and are cultivated broadcast throughout a vast sub-continent. Some of the patches lurk in remote recesses of the jungle, and others perch on inaccessible ridges of great mountains. In the Himalayan tracts one looks sheer down from the pine-clad heights, and through rifts in a shifting veil of clouds, upon dwarfed and sun-dappled mountain ranges, thousands of feet below, which in any other part of the world would themselves seem stupendous; and one sees that all their sides and buttresses are scored and contoured with a thousand narrow terraces built by successive generations to preserve the soil from being washed away. At the end of the rains the spectacle is astonishing in the vividness of the colour, for here some of the crops are of a uniform blazing crimson or scarlet or gold, and the flat roofs are covered with the orange and saffron of drying maize. The villages and farms and fields appear so near and yet so infinitely small that it is difficult to believe them real. And when one considers what must be the task of the officer who should attempt to estimate the aggregate area of all those snippets of land, cut and carved into a thousand diverse forms and sizes to suit the contours of the hills, one becomes tolerant of some inexactness.

Another spectacle which to the pure statistician has some of the horror of a nightmare, and which a visitor to India might regard as an hallucination, is that of two bullocks and a man (all nearly submerged) who move to and fro in the middle of one of India's vast rivers swollen by the monsoon rains. One passes the strange team in a launch, and there is not a speck of solid ground apparent within a quarter of a mile of them. But they are ploughing the bed of the subsiding river in order that seed may be sown as soon as the mud bank begins to show. They have waded out by a long diagonal spit not visible to us; and in the evening we may see the man stumbling homewards through the water, driving before him his pair of bullocks with the inverted wooden plough towing astern of them. But, as mud banks often change greatly in size and form from year to year, one may congratulate the local statistician on the comparative rarity of posers of this particular kind.

There are large tracts where the food of the people may almost be said to consist of "rice with variations." In the north there are others where wheat predominates, and where rice is scarcely more familiar than in European households. Elsewhere the staple food of the poorer classes may be millets of various kinds; and in Himalayan tracts one sees food crops not recognized in the plains. Throughout the country considerable reliance is placed on pulses as a supplement to the inadequate proteins of the cereals proper, but these pulses do not fall within the scope of this paper.

I refrain from quoting a number of bare statistics relating to the area and out-turn of Indian food-grains. It is practically impossible to memorize figures so large as to convey to the mind no visual image or conception. When one discusses crop areas in India, one speaks in figures in which an error of a million acres one way or another might not be noticed, so I will try to make them intelligible by correlating them with a set of dimensions that are known to most of my hearers.

In certain of the principal food-grains, like rice and wheat, there is a large export trade. India exports about one-sixteenth of her rice and one-eighth of her wheat. This trade is mainly in the hands of European merchants, though it is served by legions of Indians as cultivators, labourers, carriers, middlemen, brokers, and bag merchants. Successive crop reports, provincial and "Imperial," are published during the growth and garnering of these crops. The provincial reports are known as the provincial forecasts; and an Imperial report, though commonly spoken of as a forecast, is officially designated a "General Memorandum" upon such and such a crop. It is an important part of the functions of these forecasts that they should inform the Government and the public regarding the general material welfare of the country; but the fact that they relate only to those crops in which a large export trade is done suggests that this consideration must have weighed heavily in the successive decisions regarding their institution.

Except in Bengal, where the permanent settlement makes it unnecessary to maintain a regular revenue staff, these forecasts are compiled by that staff. The statistics for each minor tract are reported to the officer of the Administrative District in which it is situated. He prepares a return for the district, and reports it to the Director of Agriculture in his particular province; and the Director in turn reviews and, if necessary, modifies the district returns in the light of such special knowledge as he may possess, and then publishes the provincial total, which he further reports for incorporation in the General Memorandum.

General Memoranda bring together the figures for all India. Not only do the crop seasons vary somewhat as between province and province, but the systems of land tenure and revenue practice differ in a manner that imposes diversity of practice in the preparation of agricultural statistics. It thus happens that, although an attempt is made to time the issue of the Memoranda with regard to these diversities of conditions, the data brought together in a single General Memorandum are not strictly homogeneous either in nature or in respect of time. Madras may be unable at first to report regarding any but the tracts held under a particular form of tenure. Agra and Oudh may be unable to make any estimate of out-turn at a date when all the other provinces do so. Some one or other tract may already have completed the reaping of a crop about whose yield certain others are as yet able to make only a tentative conjecture.

These points are sufficient to indicate that the so-called forecasts have defects that are due primarily to the wide diversity of conditions to be faced. They will explain also why, in the earlier forecasts relating to a given crop, comparison is made between the figure now estimated and that which was estimated in the previous year and group of years at the same stage of the crop. It has sometimes been suggested that the new figure should be compared with the complete and rectified figure for the previous year; but it is obvious that comparison of a part of this year's crop with the whole of last year's would be either meaningless or misleading.

The crop areas and out-turns are verified and adjusted subsequently, and the corrected figures appear in the volume of *Agricultural Statistics*. These, however, appear too late to be of any use as a guide in the marketing of the crops.

In any case, the prime crops referred to form the subject of special care on the part of the statistician; but even as regards them his task is complicated by the fact that in one part of the country the harvest may be complete and a rotation crop may already be in the ground before, in another part of the country, the reaping has even begun. Some idea of the extent of this multiple cropping may be gathered from the following figures. The total area of land cropped in India (including Native States so far as reported) is about 390,000 square miles, each containing 640 acres, but the total area of the crops grown on that land is about 444,000 square miles. In other words, the area of the crops is greater by some 14 per cent. than the area of the land that produces them, though we must, of course, remember the fallows in rotation.

If we examine the food-grain areas we find that they amount to about 351,000 square miles. And much of the land that bears a food-grain crop at one season bears jute, cotton, or oil seeds at another season.

Before I proceed to analyse these figures in any way I must try to give some concrete idea of their magnitude. So greatly do the areas exceed the widest stretch of country that we have ever seen that the figures remain nothing but an arithmetical expression. I propose, therefore, to compare them with something of which we have acquired a visual impression, even if it be only a relative one derived from a map. Great Britain is bad for this purpose, for its straggling form and indented coast prevent us from conceiving what its dimensions would be if it were compact and rectilinear. But Spain stands out well as a unit on a map, so I will compare Indian agricultural areas with the total superficies of Spain as you see it on the map—that is to say, including all its mountains, forests, and waste spaces. Its whole superficies is about 190,000 square miles, and this would contain 1,624 Counties of London. Parenthetically, the United Kingdom has an area of about 121,142 square miles.

Now the area of recorded cultivation alone in India amounts to 444,000 square miles, and this is more than two and one-third times the area of all Spain as you see it on the map. The food-grains, with which we are primarily concerned at the moment, occupy an area of 351,000 square miles, which is about one and four-fifths as big as Spain. India exports the produce of only about one-tenth of her cultivated acreage, and of her food-grains she exports only about 6 per cent. Yet what we may call her export acreage alone is considerably larger than one quarter of Spain, and it would require an acreage equal to about one-ninth of Spain to produce (independent of fallows) the food-grains alone which India sends abroad.

I shall probably be asked on what grounds I state that India exports about one-tenth of her agricultural produce. The difficulty of making such an estimate will certainly not escape the notice of so redoubtable an audience. It would not be permissible to lump hundredweights of jute or of cotton or of cotton seed with hundredweights of rice or wheat, for the unit of quantity in each of these commodities has a different value, and represents the produce of different quantities of land. Nor—for the purpose now in view—can we reduce them all to a common term of value, firstly, because many of them are virtually not exported, and export values are not in any case applicable to produce used in the country; secondly, because export values are often rather vaguely ascertained where there are no export duties; and thirdly, because there are no up-country statistics about some of the minor articles. The only common term to which we can reduce all descriptions of agricultural produce, exported and unexported, is that of the area of ground required to produce a stated measure. We have such data about yield per acre as enable us to do this with some approach to accuracy. So, when I say that India exports about one-tenth of her agricultural produce, I really mean that she exports the produce of one-tenth of her cultivated acreage.

It is, of course, desirable to form some idea of the total value of India's produce; and, having regard to those considerations about price records which I have already stated, we see that it is only by employing the common term of acreage as an intermediate step that we can arrive at a computation of the value. As regards those crops in respect of which we have reliable data about areas, about yield per acre, and about price per measure, the matter is simple. As regards those crops or tracts in respect of which our out-turn figures are imperfect, we are sometimes able to base a fair estimate on crop-cutting experiments or on ascertained out-turns in adjoining and similar tracts. Analogous methods are followed in respect of prices or values; and to those unimportant areas that bear minor food-grains unspecified we apply, *faute de mieux*, the average produce value per acre deduced from the other food-grains. This average produce value per acre is arrived at by dividing the sum of the values of those several products in respect of which we have data by the sum of the acreages under the same products. It seems to be about Rs. 36 8a., or, say, 48s. 6d.

Before stating some of the figures that issue from the calculation here outlined, it is well to say that, while they must be accepted with reserve, there is no reason to suppose that they are much more inaccurate than the similar calculations made in other countries.

It appears, then, that India's agricultural produce has an aggregate value of some £787,500,000, while her food-grains alone are worth about £495,000,000. Now the total revenue of the United Kingdom is, I understand, about £186,000,000, so India's food-grains alone are worth some two and two-thirds times the revenue of the United Kingdom.

Years ago I published a paper in which I examined the proposition, sometimes advanced, that it should be possible to deduce from food-crop estimates some conclusion as to the quantities that would be in a sense available for export. This might be possible if there were only one food-grain, and if the inducements to exportation were constant in successive years. But external demand varies greatly, and there are many food-grains. When the supply of one is in defect, this defect may be made good by drafts on another kind of grain of which the exports may thereby be restricted. And, in respect of either of the two grains here spoken of, considerable and seemingly unaccountable exports may take place, later on in the season, when the prospects regarding the next crop in one or other of them or in a third grain that can be substituted for them are seen to be good. Another obstacle to such a calculation as we are discussing is that internal consumption in India is not constant. Many of the people are, and more of them were till recently, so poor that they were usually underfed. A rise in price could not very greatly reduce consumption, but it led to resort to cheaper forms of food. A fall in price, on the other hand, induces a more liberal diet; and if every person in Bengal alone were to increase by only 1 per cent. the average daily ration of a little more than 1 lb. of rice per head, the increased consumption in a year would represent an aggregate of no less than 84,500 tons.

When we consider that India has a population of some 315,000,000, and that 94 per cent. of her food-grains are required for internal consumption, it will be understood that an increase of 6 per cent. in the production of rice might—with a constant internal consumption—bring about a cent. per cent. increase in its exports, and that, conversely, a contraction of production on the same scale might wipe the exports out altogether but for the financial exigencies of the cultivator. These facts account in great measure for the violent fluctuations that occur in the foreign trade in Indian grain. Although Burma rice is the standard rice of the world, and although India has in several years supplied the United Kingdom more largely with wheat than any of her competitors, people outside India forget her relative importance in the world's grain trade.

The ruling factor in the Indian exports is the internal price not only of the single grain, but of those that can be substituted for it; and a somewhat elaborate study of prices which I carried out in my books on " Burma Rice " and on " Indian Wheat and Grain Elevators " leaves no doubt that at seasons other than that of the " knock-down " harvest sales, the foreign prices for Indian wheat, say, have little to do with the smallness of the trade done. India as a whole, excluding Burma, cannot be said to produce grain for the purpose of exportation, though certain irrigation tracts already do so, and others will no doubt follow.

There are tracts where irrigation or alluvium renders production so cheap that the mass of the wheat or rice can still be sold to a profit at the knock-down prices that are current at harvest time. But India as a whole parts only with so much of her food as can or must be sacrificed to liquidate certain agrarian charges; and when she has a superfluity she releases it, because it would go bad on her hands. As the Indian population grows the exporters will have to conform to methods that give the cultivator a better return for his exported produce, or they will find those methods adopted to keep the grain in the country. At present the volume of the exports of food-grains from India at harvest time is mainly determined by the exigencies of the cultivator. He has, as I have said, to sell a quantity of his produce at harvest time because he requires ready money for his land revenue, his irrigation charges, interest on borrowed money, etc. What he requires at that season is a definite sum of money. When prices are low he has to sell a greater quantity to the exporter to raise that sum. Hence the anomaly that, given a fair crop, we sometimes—though rarely—find early exports to be largest in quantity in those seasons in which prices are low. This is a point I shall have occasion to revert to. I allude to it here merely as a step in the exposition of the fact that no useful estimate of so-called " exportable surplus " can be made in respect of a single grain.

The question arises whether it is possible to make an estimate of exportable surplus with reference to food-grains as a whole. If this is to be done we must find some common term in which to express all food-grains, and we must include those pulses, etc., which are used to supplement the grain diet. Since the exportable surplus is that which under a given set of conditions can be spared from the food supply of the Indian people, the term selected must be one that expresses the relation of the products to the people, or, in other words, the food values of the several grains and pulses. These food values are known. In these food-grains the importance of the nitrogen is so predominant that, for our purpose, we sufficiently measure the food value of any one of them if we measure its nitrogen content and ignore the carbohydrates and the fats.

In other words, we sufficiently represent the total food value of a given crop if we show what is the aggregate nitrogen content of that crop. This we can do in respect of each of the foods in question; and it follows that we can estimate the total food value of all such foods taken together. This I found in 1908 to be about 6,105,000 metric tons of nitrogen. A similar calculation as regards that portion of the food-grains which is retained for consumption in India appears to give a figure of about 4,830,000 metric tons of nitrogen.

We can further say approximately what is the daily nitrogen requirement of the average native of India. On this physiological side of my subject I am indebted to Dr. McCay, of the Indian Medical Service and Professor of Physiology in the Medical College, Calcutta. The sum of his information is this—and we cannot pause to discuss Professor Hindhede's criticisms—that with a population composed of men, women, and children in the proportions found at the last census of India, the nitrogen requirements of the people would, upon the total of all India, including native States, be 5,024,000 metric tons. It is interesting to find that there is some approximation between this figure and that of 4,830,000 metric tons which I mentioned above as representing the total nitrogen content of that quantity of food-grains which is usually retained in this country for internal consumption. The difference is about 4 per cent., and this may well be accounted for by pulses and other supplementary foods. It is therefore quite probable that one might arrive at some approximate estimate of India's ability to export foodstuffs in general at a given time. But that by itself would not enable us to say which grain would be most readily exported, and this is precisely the point on which a shipper of Rangoon rice or of Karachi wheat requires enlightenment.

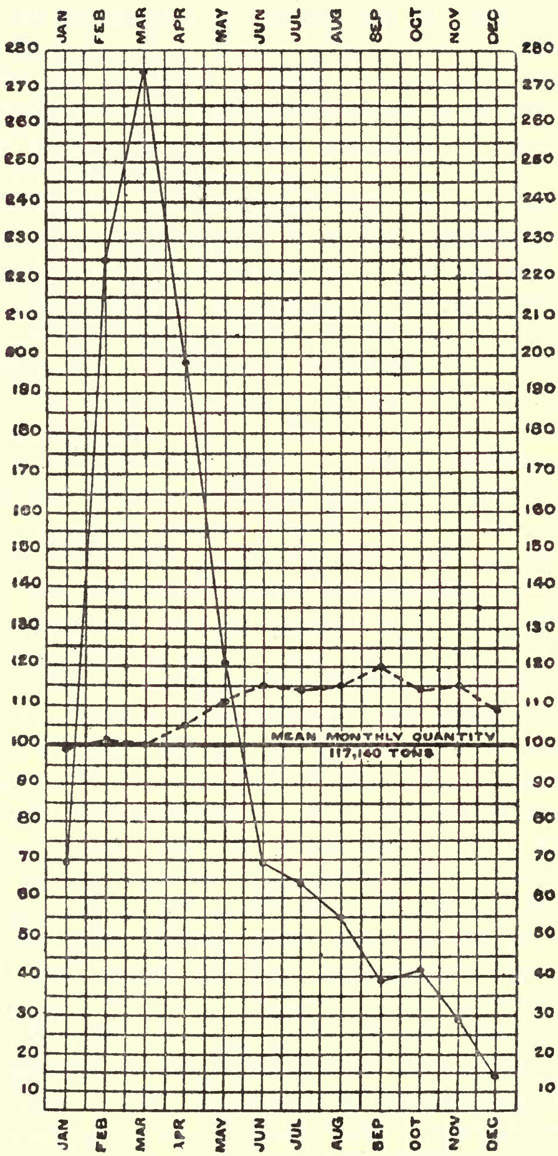
We know what is the average fuel value or energy contained in a stated quantity of Indian food-grain, and we know what is the average cost of that quantity. It is therefore permissible to speak of the said sum of money as being the price of so much energy. And when we ascertain this in respect of that quantity of energy which is required to carry the average Indian through a day's or a year's work, we have, in fact, ascertained something that might be called a unit of value. And this has great importance in the economic study of any country. All value in the economic sense ultimately reposes on such energy, retrospective or prospective, as is represented by a commodity. If energy costs little in a country, that country is in a position to produce cheaply. If, on the contrary, the unit of value be high, the cost of living will be high; and, as a producer, the country will be at a disadvantage. On these lines we find that the cost of the average Indian's aliment alone, when derived from grain, is about Rs. 11 (14s. 8d.) for one year, and less than six pies or one halfpenny per diem.

In all countries the cultivator wants ready money after harvest time. He tends to sell at once, and is deterred only by the fear that he may depress the market. Prospect of a gain in price may induce him to postpone sale, but in proportion as storage is costly or inefficient prompt sale is stimulated. In India the cultivator knows well enough that by throwing much of his produce on the market at harvest time he depresses prices, often below cost; but, on the other hand, he knows that, with such storage accommodation as is at his disposal, any attempt to hold a large proportion of a good crop would entail on him a loss heavier than is involved in his cheap sales. The storage is primitive. Rice is largely stored in granaries of wood and matting, or of beam and plaster, or of corrugated iron, raised on piles above the damp ground. Wheat is stored either in granaries of rough brickwork or sun-baked mud, or in receptacles of wattle-and-daub, or it is buried in pits. The granaries are usually on ground level, with an earthen floor slightly raised. In other words, the storage is about as rough as it can be; and when regard is had to the torrential character of the rains that in many tracts set in not long after harvest, and to the attendant high humidity, it is not surprising that the damage to grain so held is great. In India all forms of life grow rankly, and a heavy toll is levied on stored grain by insects, rats, thieves, mildew, heating and other agents of decomposition.

These enemies are common to all grain, and any saleable surplus of India's principal export grains (namely, rice and wheat) is rushed out of the country and dumped on the foreign markets with reckless disregard of the usual consequences of a glut. Not only does this system compel the cultivator to accept, up to the limit of his immediate cash requirements, any price that the exporter may offer him, but the absence of storage determines such a spate of shipment when the crop is good that the exporter's prices are forced lower than they need be.

I present two charts (pp. 74, 75) that show the effect of the system in respect of rice and of wheat. The one with the most marked peak relates to Burma rice (Chart I); that with the flattened peak relates to Indian wheat (Chart II). The Burma season for the export of new-crop rice begins in January, while the Karachi season for the export of wheat begins in April. The charts, therefore, start respectively with January and with April. Both represent the averages of a series of years, and they present data in percentages of the mean. The equator or 100 represents the mean monthly figure for the whole period; and the curve shows in percentages how far the figure for each successive month usually exceeds or falls short of that mean. The solid line represent the exports; the dotted line represents the prices at the ports. These charts repay exhaustive study, and have indeed disposed of the most time-honoured legend about the India export grain trade.

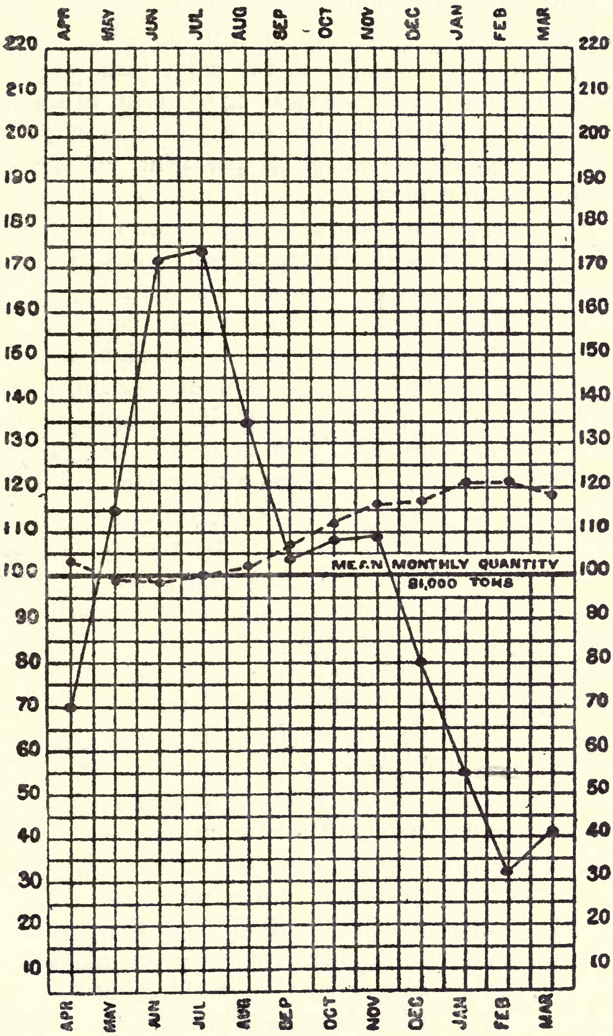
I.—BURMA RICE. EXPORTS AND PRICES.



Variations in average monthly levels.

——— in exports; - - - - in prices; 100 = Average of monthly shipments in 5 years, 1906 to 1910 (exports); ,, ,, quotations for paddy at Rangoon (Jan. to Mar.) in 10 years, 1901 to 1910 (prices).

II.—Indian Wheat. Exports and Prices.



Variations in average monthly levels.

In exports ....

In prices ....

It will be seen that in the first month of the rice season the shipments are only about 69 per cent. of the mean, but that in the next month they leap to 225 per cent. of the mean, and in March go to 274 per cent., dropping thereafter in three months to the point from which they started, and then tailing away to 14 per cent. of the mean. In the three months February to April (or in 25 per cent. of the whole period) some 58 per cent. of the entire shipments are exported. In the first six months the shipments represent nearly 80 per cent. of the whole; and in September, when prices are best, only $3\frac{1}{4}$ per cent. of the total quantity is shipped. The dotted price-curve shows not only—as was to be expected—that prices were lowest at harvest time, but that in September, or seven months after the middle of the harvest season, a rise of 20 per cent. has taken place, and this, it must be noted, not for sound grain, but for average of the grain available at the time, which contains a proportion of damage.

The peak in the wheat curve is truncated; but in its main character the chart presents a striking resemblance to that relating to rice. In each case there is a rush up to the maximum, and then a rapid decline synchronizing with a rise in price. But the nature of the two problems is different in several respects. In rice India is the largest and cheapest producer and shipper in the world, and her prices rule the world. In wheat India only comes third as a producer, and seventh as an exporter; so, great as may be the effect produced by her heavy dumping at one season, the seasonal demand is limited, as is shown by the truncation of the curves. But we find that, in fact, the internal prices of both grains are markedly lowest at harvest time, and that, while the price of rice rises by 20 per cent. in seven months, that of wheat rises by 21 per cent. in eight months.

Another point of difference between the problems relating to rice and to wheat is that, while the wheat is exported after being merely threshed, the rice is for the most part milled before shipment. And the milling of rice involves processes in which it is important that the grain should be uniform in size and homogeneous in character. Lack of uniformity in these respects results in imperfect husking of the lesser grains and heavy breakage among the larger and more valuable grains. But under the existing system the diverse kinds of rice inevitably get mixed during the frantic rush of the short rice season. So this rush, besides involving reckless buying, in which the middleman is master, besides enhancing ruinously the cost of labour, of cartage, of railway freights, and of transport by country boat, by river steamer, and by export shipping, leads to most wasteful milling, and keeps Burma's product in a position of inferiority which it need not occupy.

And there is no truth in the ancient legend that these evils are compensated for by a supposed elevation of price at harvest time. Both in rice and in wheat the rush is due to the existence of a comparatively wide margin between European prices and produce prices. This wideness of margin is due in the main to the lowness of the Indian producer's price, and the lowness of that price is due to the facts already stated—that he must realize a part of his crop, and that he has no means of storing a large surplus in safety.

Later on the Western prices of wheat drop a little under the influence of supplies from Canada, America, and Eastern Europe; and the exporter in India used to imagine that if his "limit" had not been lowered he might have gone on shipping. Only in recent years has it been pointed out that, as a rule, the internal prices rise so greatly that four months after harvest the exporter is entirely "out of it." In some years the rise has been so great that grain shipped to Europe has very nearly been reimported.

These facts have in the last seven years been established on the basis of ten years' averages, and some years have passed since any attempt was made to controvert them publicly. They are not affected by the circumstance that in some single years abnormal conditions may have put initial prices at so high a level that later prices showed a decline. The established facts have been made the ground of proposals for the institution of such a system of modern bins, silos, or elevators throughout the country as would serve the purpose of a reservoir, would avoid the necessity for throwing the bulk of the export grain upon the market within a short time, and would enable a merchant to hold grain in security or to borrow on good terms on a rising market.

Another factor that has stimulated interest in elevators has been railway congestion. India has had a succession of most prosperous years. The congestion on the railways has at times been very great indeed, and it has been greatest in the season for the movement of wheat and seeds. It has been injurious not only to the trade in these articles, but to every trade that had goods to be moved; and the proposal for the adoption of grain elevators has found many converts among the general merchants, whose business is disorganized by the spate of wheat and seeds. Now that they understand the matter these merchants are beginning to resent having their trade injured, because in India, as in Argentina, the vested interest in the wheat export trade deprecates the adoption of a system which they fear might at once make the seller somewhat independent and facilitate the entry of competitors into a close preserve.

Among the converts are also many railway men. Formerly they feared that elevators might put an end to the export trade by facilitating retention of the grain in the country, and might so deprive the northern railways of a great deal of traffic. But the conviction has gained ground that the present system of recurring congestion, with redoubled clamour for more rolling stock and track and crossing stations, is not business, and that working will be much more profitable if the grain should go forward as it is wanted in consumption. The admission is also now made that when the large new irrigation tracts in the wheat regions are ready wheat will probably not be grown on them, and the railways will have no additional wheat to carry from them, unless such arrangements be made as will enable the cultivator to hold his produce in safety till it can be carried and until he can command a price that covers cost. If these conditions can be secured, it seems probable that an additional 2,900,000 acres may be put under wheat, and an additional 1,283,000 tons of that grain will be available. And it must be remembered that in irrigation colonies the sparseness of the population and the tendency to produce only the great staple products cause exportation of an exceptionally large proportion of the out-turn.

It seems evident that any such additional quantity thrown on the market at harvest time must crush it as well as the railway organization. In a year of good crops much of it would be available for export. But in a year of good crops prices are low, such portion of the wheat as is sold for home consumption is sold cheap, and if the cultivator finds himself still unable to hold his surplus in safety, and obliged to let it go at such knock-down prices as a gorged export trade can offer, he will not put his land under wheat again. These considerations are gradually making their little impression; and, to cap them all, comes the accumulating evidence that European ports are rapidly completing their equipment for the handling of bulk wheat, and will, before long, require India either to supply in bulk or to knock something off her prices.

All these considerations have a special interest for Bombay, which twenty years ago was the chief port for Indian wheat. Karachi has in recent years spent large sums on facilities for handling grain in bags, and some of the local opponents of the elevator proposals argue that this expenditure obliges Karachi to continue on the old lines. Bombay, on the other hand, having ceded the premier place in the wheat trade to Karachi, and finding herself already obliged to contemplate further port equipment for the handling of produce, is disposed to think that she might get back a little of her own if she were able to come forward with an offer of sound bulk wheat brought in by the two great railways that serve her.

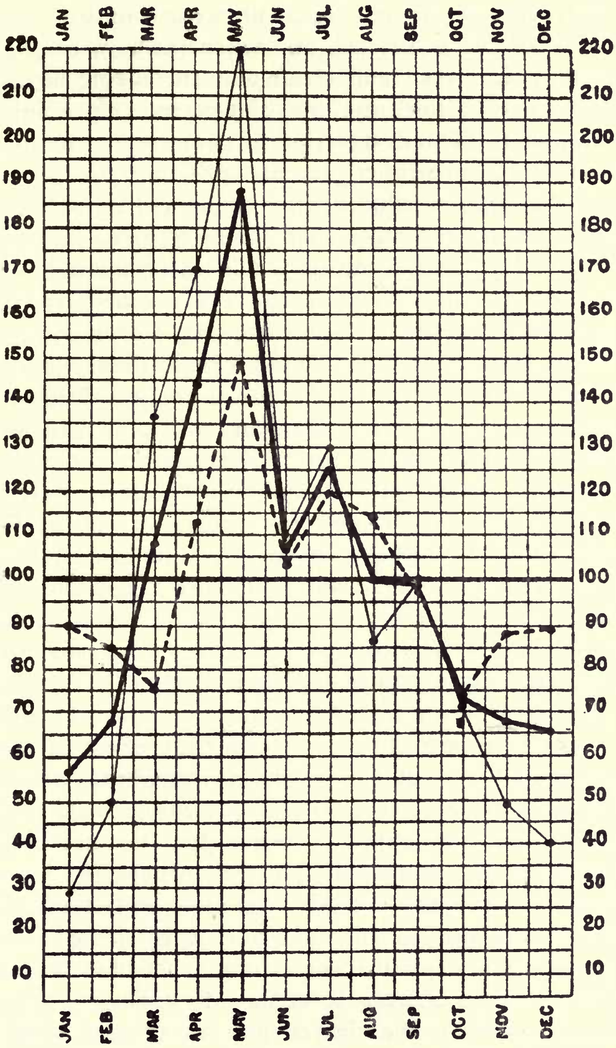
While this question of elevators relates most evidently to wheat, it remains to be seen whether it may not also affect rice. This is my reason for disposing of it before proceeding to discuss these two crops separately. I can find no record of storage of rice in bins in any country. If any of my hearers can refer me to such experience I shall be grateful. Rice—more particularly rice in the husk—

mildews and heats very readily. It is probable that Burma rice in the husk (which contains about $11\frac{1}{2}$ per cent. moisture) would go wrong if stored in bins in the condition in which it reaches Rangoon, and in the presence of the high humidity and temperature there encountered. But research work and some interesting experience acquired with rape seed in recent years have shown that the organisms that cause this form of trouble are inhibited by drying. It remains to be seen whether great masses of rice could be profitably treated with modern drying appliances, and whether dehydrated air should be employed in view of the high temperatures and humidities encountered at some times and places in India.

At all events, the chart I have given (Chart 3) leaves no doubt that the present system must glut the market. Rice, like all similar materials, is wanted in constant volume in the consuming markets. But not only does Burma throw the bulk of her rice on the markets at one time, but her doing so synchronizes with the arrivals of the mass of the rice from the other principal sources. The principal sources lie north of the Equator. The Dutch East Indies lie south of the Equator, and the rice harvest there is some six months later than in India, Saigon, etc. Java rice, therefore, comes on the European markets when they are bare, and it consequently sells at a premium very much greater than can be accounted for by its superiority. It remains for merchants and millers in Burma to consider whether it would pay to dry rice to safety point, to hold it in bins, and to send it forward when the glut of other rices was over. This operation would appear to offer the advantage that before the time for export had arrived the "rains" would have defined themselves for good or ill, and the holder would be able to choose between the foreign and the Indian markets.

There is no time at present to go at length into the engaging habits of that prolific and pervasive insect called the weevil, or to describe the devices that we are adopting to circumvent him. No food-grain seems to be immune to his activities; and if only 5 per cent. of India's food-grains are destroyed by him, the total loss

III.—IMPORTS OF RICE INTO UNITED KINGDOM. CENTESIMAL VARIATIONS IN THE MONTHLY IMPORTS ON THE AVERAGE OF FIVE YEARS, 1906 TO 1910; THE AVERAGE FOR THE SIXTY MONTHS BEING TAKEN AS 100.



Imports of Rice into United Kingdom.

Mean 245,058 cwt. from India ....

,, 220,722 ,, from other sources ....

,, 779 ,, total ....

must approach £25,000,000 sterling. He thrives in the bland or sweltering airs of the great sub-continent. He lurks amid the dust and detritus of last year's crop, in every crevice of the sun-baked brickwork or the bamboo matwork of the granaries, and when the new-crop grain is brought in, fresh and clean and succulent, he sallies forth in his (and her) myriads, and performs prodigies of reproduction. The destruction of grain is enormous, but it has never been properly ascertained in India, although in some laboratory experiments conducted by Mr. David Hooper, of the India Museum, some 65 per cent. of the grain was found to be destroyed in three months. In a recent Nyasaland publication the average loss by weevil in that country is put at about 25 to 30 per cent. In places one finds among the people an extraordinary delusion that the weevil does no harm. A Burman advanced this theory to me some years ago, and when he had at my instance fetched a sample of his last year's rice and had been shown a very large number of hollow grains, he said: "Oh, yes, no doubt; but the rice is always winnowed before it is used, and all these hollow grains go away." The idea that their departure represented loss eventually dawned upon him and set him grinning. A parcel of grain which has once been "infected" by weevil may "break out" at any time. In other countries the weevil is occasionally dealt with by means of fumes and gases; but in India we are at present trying the effect of simple drying, and the results, so far as arrived at, are very encouraging. Gases have the disadvantage that, though they may kill the parent weevil, they do not readily penetrate to the interior of the grain where the larva is feeding; nor is it at all likely that they will sterilize the eggs. But it appears that not only does the weevil die when a certain point of dryness is reached, but the larva is unable to feed or even to come into existence. There are many points to be cleared up, but the study of the question is being prosecuted at the Agricultural Research Institute in Pusa and in the Punjab; and there is some expectation that drying may be found to afford protection against weevil as well as against mildew. The work of Mr. Fletcher and Dr. Leather points to 8 per cent. as about the safety point in wheat. It is suggested by some merchants that since drying involves loss of weight it would not pay. But all users of grain will pay for assured dryness, not only because of the greater security of their stock, but because it gives them a potential gain of weight during the conduct of their industrial processes. All that is necessary is that they should be sure that they will get dry grain, and I understand that this consideration is the basis of the new terms of business in respect of maize shipments. Another example is afforded by the description of Indian rape seed called toria. Up to two years ago toria stood at a heavy discount as compared with what was called "brown Cawnpore." It now commands a premium, and it is asserted by some shippers that this fact is—not entirely, but to a considerable extent—due to the more thorough drying instituted after very heavy losses had been made as a result of damp in 1911.

I have already said that I aim in this paper not at imparting statistics, which can be better mastered by eye, but at giving you some idea of the magnitude, the characteristics, and the main problems of the several grain trades. I take rice first, as it is by far the greatest.

The rice crop of British India alone occupies 123,017 square miles, whereas the entire area of the United Kingdom, including all its waste spaces, is only 121,142 square miles.

The average out-turn is about 29,488,000 tons. I confess that the figure conveyed very little to me even when I adopted the expedients of the popular magazine, and told myself that to transport this quantity I should have to employ more than 29,000 trains, each consisting of fifty 20-ton wagons, or a fleet of 4,900 large steamers. But I began to understand when I visited Burma in the height of its rice season. Then I travelled day after day through countries clothed with a mantle of rice which reached to the horizon on every side. All the land was alive with little people reaping, carrying, moving to and fro like ants on festival; and the landscape twinkled continually with a myriad golden jets of chaff and grain thrown into the air for winnowing. The whole landscape rustled and flickered with rice. By paths and roads the driblets of India's greatest product were beginning to move, carried in baskets by countless Burmans and immigrant Indians, or by legions of bullocks in picturesque carts lined with matting to contain the grain in bulk. By creek and ditch and backwater moved thousands of boats of every size and shape, and their sails could be seen flitting deliriously through fields and by bamboo clumps and groves of hardwood. As the streams and waterways spread out, the craft seemed to multiply and spawn upon their surface until, in the great canals by which they reached the Rangoon River, they created such a spectacle of progression in a state of deadlock as only the East can present. The spate of grain submerges the railways, submerges Rangoon and Moulmein and Bassein and Akyab, and chokes the mills and rears great billows of golden grain on every vacant space, and then pours out across the sea in scores of ships, feeding the further East and swamping the markets of Europe.

And in everything that the Burman does he is a person by himself. A most untimely rainfall set in during the rice harvest of 1912. Early one morning I saw a Burman perched precariously on the slope of a great hill of sodden sheaves which he was trying to save. Anyone but a Burman would have taken his clothes off to a job of that kind, especially as it was pouring cats and dogs. But the Burman was clothed in variegated silks, and with his right hand he held an umbrella over his head, while with his left he threw one little sheaf after another up into shelter.

India supplies about 68½ per cent. of the Western world's imported rice. Burma supplies about 63½ per cent. of it. Burma also sends some 837,000 tons of rice to India proper, so that her whole shipments amount to something like 2,250,000 tons.

The respective systems on which rice and wheat are usually bought from the cultivator for export differ a good deal. Whether there would have been roads in Lower Burma and the Delta if there had been fewer waterways it is impossible to say. Certain it is that roads are almost non-existent, and that, but for the large number of waterways that thrid the land, the rice trade as it now exists could not have come into existence. It is the growth of about fifty years; and the system of local markets has not advanced as in the Punjab wheat tracts. Many months before harvest the country is alive with so-called brokers, who receive money from the millers and make advances against the next crop. When the harvest is at hand they distribute bags on a variety of terms, and then they buy all they can at prices that leave them a profit on the rates given them by the millers. But most of the transactions are carried out on the cultivators' own premises, whereas in the Punjab the cultivator with wheat to sell usually brings it to a common market, where it is exposed for sale or made over to the agent to whom it has been hypothecated.

In these local markets the wheat is either displayed in bulk on matting spread in the open, or is represented by samples. In the central part of the Punjab the wheat is carted to the market in bulk. In other places much of it is brought from field to market in bags, is unbagged for inspection at the market, and is then by the owner rebagged for storage or for despatch by rail. In the north-west tract there are no carts, and the grain comes in on pack animals—bullocks, asses, and camels.

Looking back over the last ten years, we see that there have been some big events in the Indian wheat trade. The most important have certainly been the growth in irrigation, the creation of vast wheat colonies where there was desert before, and the inception of still further irrigation measures. Then there were the enormous shipments in 1904, when India exported 2,150,000 tons, and the United Kingdom took more wheat from India than from any other single source; and the striking contrast of the exports in 1908-09, which amounted to about 5 per cent. of that figure. More potent as factors in the future have been the alteration in 1907 of the terms of the Indian contract reducing percentage of admixture, and the increasing tendency to ship cleaner wheat, until it becomes evident that India could work on a perfectly clean basis. Associated with these is the appearance of a large export trade in barley cleaned out of the wheat.

The wheat area of India is about 42,822 square miles, and its out-turn about 8,400,000 tons. The area seems small beside the rice area of 123,000 square miles, and yet it represents something like a quarter of all Spain. The irrigated area under wheat averages about 8,547,300 acres, or 13,355 square miles, and to this is to be added the 2,900,000 acres, or 4,511 square miles, expected to be put under wheat in those irrigation tracts that are about to be created. This will make in all some 17,800 square miles of irrigated wheat.

In certain recent years India has exported large quantities of barley. The average quantity exported in the five years ending 1910-11 was about 29,500 tons. In the year 1911-12 it went to 292,500 tons, while the figures for 1912-13 touched 615,200 tons. That for 1913-14 has gone back to 190,400 tons; but I find it to be agreed that the demand for Indian barley will persist. There is a difference of opinion as to whether most of the Indian barley is used for malting or for feeding. I understand it to be a fact that East Indian barley is bought under the Feeding Stuffs Contract of the London Corn Trade Association.

The main interest of the barley figures is less obvious than their magnitude. In the first place, the comparison of the earlier with the later years is probably illusory to some extent. In the second place, the development illustrates one step in the evolution of a trade specialized on modern lines, and it shows how improved organization in one branch of trade may entail changes in another.

The figures I have quoted understate India's real exports of barley, and such understatement is more marked as regards the years anterior to 1911-12. Formerly the barley was exported in the wheat and swelled the figures relating to that higher-priced grain. Up to 1907 the proportion of barley permitted under the Indian wheat contract was 5 per cent., and in many shipments this was considerably exceeded. Even if it had been strictly adhered to a very large quantity of barley must have gone forward. For 5 per cent. on 1,000,000 tons of wheat is 50,000 tons of barley; and India's average exportation of wheat used to be not far short of that.

In large tracts of India barley is sown and grown mixed with wheat. The operation of separating the barley from the wheat takes time, and it is unprofitable if the outlet for the separated barley is bad. Dealers and shippers of wheat alike found it more profitable, and more convenient in a spasmodic trade like theirs, to ship the barley in the wheat, and to take the risk of allowances than to separate it out and sell it on a narrow local market. Millers at home were equipped for separating the two kinds of grain, and were prepared to accept a little extra barley without great complaint, so long as they got a reasonable price for it on the home market.

The barley, after being separated by the millers, was often mixed with barley from other sources; and even when it was not so mixed there was probably no gratuitous advertising of its origin. It was bought and used by stock-feeders, brewers, and others who did not concern themselves about its source, and who tolerated as customary a certain proportion of dead grain.

In 1907 the terms of the Indian wheat contract were so altered as to limit to 2 per cent. the admixture of barley in wheat cargoes. For some years this was not strictly adhered to. It took time to get the new system into working order. There was no large local market for barley, and Indian barley as such was little known on the European markets. Consequently, there was for some time a persistent disposition to ship excess barley and to meet such allowances as might be due. But the tendency was towards elimination of barley. The supply of barley separated in India increased in that country, and there was a corresponding decrease in the supply in Europe of barley derived from Indian wheat cargoes. In the Indian market barley in the harvest season became relatively cheap. Conversely, in those months in which Indian supplies had formerly come forward, the price of barley in the United Kingdom hardened. A margin appeared. Experimental shipments were made. The business was found relatively profitable. The separation of barley was therefore carried further, and it became the general practice to ship Indian wheat without any excess barley.

The supply of barley in the United Kingdom was still further curtailed, and the home market became sensitive to any actual shortage. Such a shortage appeared in 1911, when it was found that drought had affected certain European crops, that England's crop showed a large reduction, that America had little barley to spare, and that other sources in the Near East (with the exception of Tunis and Algeria) were not sellers. Whereas the price of barley was to the price of wheat in the two years 1909-10 and 1910-11 as 72 is to 100, in 1911 the ratio rose to 82 per cent. Such an approximation of price reduces considerably the temptation to ship excess barley in Indian wheat. It is not surprising that Indian barley has found a ready market and that her exports have increased.

But it is to be noted that India would probably not have been able to cut into this trade if she had not adopted the new form of wheat contract in 1907. And it is probable that the establishment of Indian barley on the home markets, in so far as it affords a regular outlet, will definitely fix the practice of shipping wheat free from barley. How far it may abate the practice of sowing the two grains together remains to be seen. But in January, 1914, I was present at a Conference which the Director of Agriculture in the Punjab had with the Indian wheat merchants at Lyallpur on the subject of their using the elevator at that place, and I was greatly surprised to hear them express perfect willingness to work on only two grades—one white and one red—both free from barley.

There have been complaints about the presence of perished grains in the barley shipments. Such a condition in barley is usually the result of fermentation caused by excessive moisture. The fact that Indian barley is grown along with a more valuable crop whose condition decrees the time of cutting may possibly lead to premature harvesting of the barley. But I doubt whether there is much in this, for the barley tends to mature earlier than wheat. It is, in fact, probable that some perished grain has always been present in Indian barley, but that the complaint now finds voice for the first time largely because, under the old conditions, consumers did not know whence the barley had come.

There can, I think, be little doubt that during the time of strong demand and high prices old stocks were produced and mixed with barley of later date. Much of this old stock had been for years in pits and in other receptacles where damage was incurred, and it is probable that the exhaustion of these old stocks is sufficient to account for the improvement in the quality of shipments. At the same time, any marked and protracted restriction of the shipments, with consequent reaccumulation of stocks, might bring about a recurrence of the trouble. For while grain that is stored in pits is comparatively free from weevil there is usually a good deal of rot. It is believed that the decomposition of a certain amount of the grain generates carbonic acid gas in sufficient quantity to prevent the breeding of weevil. But I am informed that in the course of experiments made in recent years in treating grain with carbon dioxide for the prevention of weevil, curious results have been encountered which suggest that protracted treatment with the gas may sterilize the grain in the sense of rendering it incapable of germination. Neither in wheat nor in feeding barley does such sterility matter, but to brewing it is fatal. It is evident from the interest taken by maltsters in these problems that the discovery of India as a source of malting barley is more than an incident, and may prove to be an event. Proposals have already been made for the establishment of such a system of storage and handling as would secure all those conditions that elsewhere are believed to guarantee uniform germination. But such a system would cost money; and unless there were perfectly unequivocal assurance that the expenditure would be recouped by better prices the system would not be adopted. For there will always be a market for India's barley for feeding purposes. And India, in spite of her amenability to philosophical sophistry, is singularly sceptical about new propositions of a practical kind.

There has been some discussion as to whether the condition of Indian barley could be improved by storage and handling in elevators. One of the objections most promptly brought against this suggestion is that uniform germination is so important that every maltster's lot must be homogeneous, not only in condition, but in respect of percentage of nitrogen content, and therefore in respect of source. I cannot say whether, in fact, such Indian barleys as are at all likely to become mixed in transit from their respective sources to the coast show a really pernicious divergency in nitrogen content, and whether—seeing that barley is likely to be more cultivated in the future unmixed with wheat—it would not be possible to introduce greater uniformity in kind. Stagnation is very often the result of stickling for such a counsel of perfection as is involved in the keeping separate of all the barleys from different tracts, and it must be admitted that there is something attractive in the idea that barley might be made to profit by, and also to contribute to that adoption of grain elevators which many persons in India foresee.

Barley has not as yet been made the subject of a crop forecast, though a proposal to this end has been for some time before the Government of India, and has been approved by the Indian Chambers of Commerce. The percentage of admixture of barley as grown along with wheat varies so widely that any estimate of the out-turn and of the equivalent in acreage must, in the absence of a forecast, be very conjectural. At present the crop is believed to cover about 8,882,000 acres, or 13,880 square miles, to amount to about 3,889,000 tons, and to have a value of more than £15,000,000.

I will not attempt an analysis of such export trade in maize as exists. The grain was not distinguished in the Indian trade statistics before April, 1912, and in the agricultural statistics it is not distinguished now, so there is no record on which to found conclusions or even inferences. Some 21,000 tons of maize were sent abroad in the calendar year 1912, but in the official year 1913-14 the shipments amounted to only about 2,900 tons.

The only head under secondary food-grains that shows an increase of exportation in 1913, as compared with 1912, is that of "Jowar and Bajra," which are millets. The exports of these in 1913-14 had a total of 84,000 tons;

but since the area under these two crops is very great, amounting to 42,551,000 acres, or 66,500 square miles, the exports probably represent less than 0·3 per cent. of the production. The area under these two crops, whose very existence is scarcely recognized outside of India, is considerably greater than one-third of all Spain, or more than half of the United Kingdom, is greater by 23,700 square miles than the area under wheat, and largely exceeds one half of the Indian rice acreage.

But in some ways the most impressive food-grain areas we see in India are those where irrigation assures the crops. The total irrigated area runs to some 44,460,000 acres, or getting on for 70,000 square miles, which is much more than one-third of all Spain. Under irrigated food-grains and pulses alone there are some 33,787,000 acres, or 52,800 square miles. There are in this world few spectacles more striking than that presented by some great irrigation "colony" which a few years ago was a desert garnished only by thorn bushes and a few emaciated camels. Now one steams for hours across a country that in the cold weather spreads to the circular horizon in a sea of green splashed with the gamboge of mustard in flower, or later on ripples, as far as the eye can reach, with tawny oil seed crops and ripening grain, while the Himalayan snows peer and shimmer through the haze. In Burma in the rice season, or in Eastern Bengal when the jute is up, one may see a stretch as wide and homogeneous. But in Burma or Bengal the scenery is broken by masses of giant trees, whereas here, in the Punjab colonies, one can mark the progress of the saplings year by year and almost month by month as they break up across the horizon. When the wheat crop comes to harvest here, as in Burma, the whole land rustles with golden grain and chaff and straw; and as the boats pour down the waterways of the Burmese delta, so the lumbering Punjab carts with their teams of antediluvian buffaloes plough through the ruts of the dusty tracks, while goods trains hurry the wheat to the coast and crowded passenger trains bring over larger hordes of labourers, with their families and household goods, drawn from other districts by the high harvest wages.

And I do not know that there is any more striking contrast between the two countries than that presented by the genial, friendly Burman, on the one hand, plying his business with little official aid beyond that afforded by the *pax Britannica*, and, on the other hand, the sour ungraciousness with which many of the peoples of Upper India seem to enter into ownership of the new world that irrigation has created for them. The fact is that they do not understand. They are immigrants. They have left their traditions behind them, and are "on the make." They did not know the country as it was, and they do not really conceive the wealth of crops to be a gift of their rulers. That, of course, is perhaps the most tiresome part of an official's life in India, that the good folk who profit by his effort very often remain unconscious even of the very fact that it has been made.

BURMA RICE.

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In the present paper it is not intended to enter largely into the commercial aspects of the Burma rice trade, but to deal more particularly with methods of cultivation and with the nature of the rice plant as cultivated in Burma. Those who are interested in the strictly economic aspect of the matter may be referred to a paper entitled "Burma Rice," recently written by Mr. F. Noël-Paton, Director-General of Commercial Intelligence, India.[1] In that paper a very full account is given of the methods of buying, storing, transporting, milling, and exporting of the product, and many important problems of the future, such as the use of elevators, are discussed in detail.

Statistical Aspect.

As a preliminary to the present paper, the salient statistical aspects of the trade may be briefly recapitulated. In rice-producing area Burma ranks only fifth among the great Provinces of India, Bengal being first with some 50,000,000 acres, while Burma, during the season ending June 30, 1913, had only some 10,000,000 under cultivation. Despite this fact, Burma accounts for 75 per cent. of the total exports of rice from the Indian Empire, and contributes 63 per cent. of the Western World's imports, while India proper contributes 1·3 per cent. only. The reason for this apparent anomaly is that in Burma the population is small in proportion to the area under rice, the acreage per head being 0·832 for Burma, as against

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[1] Calcutta, Superintendent of Government Printing, India, 1912.

0·496 for Bengal and 0·250 for Madras. Accordingly, a large surplus is available for export.

Paddy (the name usually applied in India and Burma to the unhusked grain of the rice plant) destined for export finds its way to one or other of the principal seaports of Rangoon, Bassein, Moulmein, and Akyab, where the principal rice mills of the province, which are mainly in the hands of European firms, are found. There the rice is partially husked and exported as "cargo" rice.

The increase in the acreage and in the amount exported has been continuous up to the present year (1914), when the record total of 2,944,000 tons of cargo rice left the province. Of this 1,292,000 tons were shipped to Europe, 895,000 tons to India, and 705,000 tons to the Straits. The remainder went to Japan, Ceylon, Mauritius, Zanzibar, and Réunion. A fact which must be borne in mind, however, is that the rice acreage of Burma, in the main tracts at least, has now practically reached its natural limit, and that future extension can only be the result of irrigation and of more intensive cultivation.

On the other hand, it is to be borne in mind that over all of the great rice-producing area of Lower Burma and the Irrawaddy delta the crop is not at present competing, nor is it likely in the near future to compete, with any other crop. The most probable development of agriculture in these parts is second cropping by means of well or other irrigation, and the adoption of such a system, owing to the improvement which dry working and leguminous crops, such as beans, would produce on the paddy soils, would tend to increase rather than diminish the total yield. We have the further fact that at present Burma has few great non-agricultural industries, so that a very large internal demand from a rapidly increasing urban population is not likely to arise in the near future. In certain tracts of Upper Burma, notably in the Mon-Canal area of the Minbu District, paddy is likely very soon to meet with a competitor in sugar-cane, but over the main rice areas of the province neither sugar-cane nor jute is likely to oust the crop from its present position of importance. Hence we may conclude that Burma's rice trade, if it does not show a marked increase, is not likely to diminish much in volume in the near future. The diminution when it does occur will probably be slow.

Cultivation in the Deltaic Region.

Burma may be divided into three great climatic tracts: (1) A southern tract of high rainfall ranging from 70 to 200 in., including the Arakan and Tenasserim, Pegu, and Irrawaddy Divisions; (2) a central tract of low rainfall averaging from 25 to 35 in., and including the Magwe, Meiktila, and part of the Sagaing and Mandalay Divisions; and (3) a northern high rainfall tract, embracing mainly the Districts of Katha, Ruby Mines, Myitkyina, and Bhamo, where the rainfall ranges from 60 to 100 in.

In the first of these tracts, the deltaic region, the main rice crop of the province is grown. Except for the Arakan and Pegu Yomas and their off-shoots, the country presents the appearance of a great flat plain of alluvial origin and watered by the Irrawaddy, Rangoon, and Salween rivers. The soil of the region is lateritic in origin, and varies from a sandy loam to a darkish clay. The surface soil is in all cases characterized by the extreme rapidity with which it loses water as soon as the rains are over, so that attempts at cultivation without irrigation can only end in failure. On this great plain paddy cultivation begins in June, when the nurseries are made, for the great bulk of the paddy grown is transplanted. Cattle manure is usually applied to the nurseries in May before the rains break, but hardly ever to the transplanted fields. Manuring of the latter is a much to be desired improvement as experiments at the Government Agricultural Station of Hmawbi have shown that a very considerable increase in yield can be got by manuring poor soils in this way. At present cattle manure is neither economically stored nor applied to the soil, and the whole system of cultivation is to be considered extensive rather than intensive. It is at present in the same stage as wheat cultivation in Canada, where the rough cultivation of large areas rather than the careful cultivation of small is the practice in vogue. On these same soils experiment has also shown the efficacy of oil cake (cotton), cyanamide, and phosphate as manures for paddy, but their use would depend on their price, which is at present too high. The practice of green manuring has been found to be attended with difficulty, for the reason that the monsoon breaks with great abruptness, so that the soils are either as hard as brick or are soft mud. Hence proper cultivation of green manure plants cannot be effected. There is, however, a very great natural growth of grass and sedges in the early rains of May, June, and July, and this growth is ploughed into the soil in August. Its presence probably tends to maintain fertility owing to its providing a suitable mechanical texture.

Burman cultivators usually recognize four main kinds of crop: (1) Kaukyin, or very early maturing varieties, having a growth period of about 75 days; (2) Kauklat, or medium varieties, with a period of 75 to 100 days; (3) Kaukgyi, or long-lived rices, of which the period extends up to 120 days; and (4) Kauknyin, or glutinous rices. The latter are a class apart and are never exported, but used for particular purposes at pagoda festivals and the like. The distinction into the three grades of ordinary rices mentioned above is one that is necessitated by differences in the water supply. The short-lived varieties are grown on the higher fields, which lose their water first, and the long-lived varieties on the lowest lying fields.

The ordinary seed rate for paddy is about one basket of seed per acre of transplanted field. This could probably be lessened, as experiment has shown that in certain cases the usual practice of planting two or three plants together is wasteful and unnecessary. Reaping of the main crop is done in December and January, in which two months large contingents of labourers from Madras and Bengal visit the province, returning to their own country when the harvest is over.

In Lower Burma wages are high, and R. 1 a day is a usual coolie rate at busy times.

The yield on these Lower Burma soils varies from 1,500 to 4,000 lb. of unhusked rice per acre. Cropping is continuous, no manure is used except on the nurseries, and no rotations are practised, hence it is a common complaint in many places that yields are declining, a complaint which indicates the present time as one of necessary transition from extensive to intensive methods of cultivation.

Cultivation in the Dry Zone.

The central or dry tract of Burma is a climatic island, which owes its peculiar weather conditions partly to the presence of the Arakan Mountains, and partly to its inland position. The mountains not only rob the monsoon of its moisture, but deflect its course, so that in all parts of the dry tract the prevailing monsoon wind is south-east instead of south-west. This is the region of dry crops of sesame (of which Burma possesses the largest acreage in India), sorghum, maize, beans, and cotton. Here, except in the irrigated areas, which the British Government has been sedulously extending since the annexation, rice is a crop of secondary importance. The country is one of broken uplands, with small valleys in which the monsoon water collects. On the higher grounds sesame, jowar, and cotton are planted. Hence in this central tract it is in the irrigated areas that we must look for extensive acreage under rice, and these areas, in which the cultivation is mostly all of recent date, are now helping considerably to swell the export trade. The main irrigation systems instituted or maintained by the British Government are as follows:—

Mandalay...	...	...	77,955	acres.
Shwebo ...	...	...	158,292	,,
Minbu ...	...	...	91,186	,,
Kyaukse ...	...	...	136,568	,,

The first three have all been formed since the British occupation, but much of the irrigation in Kyaukse owes its inception to the Burmese kings. Cultivation of paddy on these areas is practically similar to that in the non-irrigated tracts of Lower Burma, but in Kyaukse two crops per annum are often taken, or the crop is rotated with sugar-cane or sesame. Most of the soils in the Mandalay and Shwebo tracts consist of intensely stiff clay, which cracks into large and deep fissures in the hot weather. In Kyaukse and Minbu more variety is found, and especially in the Mon-Canal area in Minbu large stretches of friable loam resembling the Gangetic soil in texture are found. It is on these latter that the rice crop may expect to find a competitor in sugar-cane as time goes on.

Quality and Defects of the Grain.

The quality of Burma rice does not come up to that of the best of other countries. Many of its defects are due to premature harvesting, faulty storage, damage from insects, and other causes. From the miller's point of view it is defective in three particular ways:—

(1) It contains a large percentage of red grains. Apparently the redness is objected to by the consumer, and must be got rid of in the mill as far as possible. To do so means setting the hullers so closely that white grains are smashed, and a large percentage of broken grains seriously lowers the value of a sample.

(2) A considerable number of the varieties grown are possessed of awns, and these latter have a similar effect, viz., they increase the amount of break. Unevenness of grain, a result mainly of mixing different varieties on the threshing floor, produces the same result.

(3) Samples usually contain a considerable amount of stones and dirt, which have found their way into the stocks either by accident or design.

Accordingly, the desire of millers is for a bold grain, *i.e.*, a grain which in shape approximates to the spheroidal rather than to the cylindrical form, of uniform size, not possessed of awns, and which on husking presents a vitreous appearance, with no trace of red. At a recent Agricultural and Co-operative Conference held in Mandalay, the representative of the Rangoon Chamber of Commerce, in a paper read by him on this subject, remarked as follows:—

"Every rice-consuming market in the world is protesting against receiving either rough or cleaned rice which contains more than an extremely small proportion of red grains. No amount of milling will eradicate the red tinge from even the better qualities of cleaned rice, while in rough rice and the lower grades of cleaned rice the red colour is only too obvious."

Improvement of the Crop.

To bring about the desired improvement in the quality of paddy grown, the Government of Burma have established two large Experimental Stations of about 400 acres each, one at Mandalay, which includes irrigated rice among other subjects of its programme, and one at Hmawbi, near Rangoon, which deals entirely with the non-irrigated rice crop of the great deltaic region. The latter station has only completed the third year of its existence, but even already some interesting and important results have been obtained.

The work at these stations is to consist of (1) the improvement of rice varieties by selection or hybridization, with the special purpose of meeting the exporters' requirements; (2) the institution of experiments to test improved methods of tillage and the introduction of improved implements; and (3) manurial experiments.

In connection with (1), a collection of over 300 varieties of the kinds likely to suit millers has been made at Hmawbi from all the Lower Burma rice districts. These are now being grown in single-ear cultures, and will be maintained as a permanent collection for purposes of reference.

From this collection a number of specially suitable types were chosen last year and subjected to intra-varietal selection by the pure line method. The adoption of this method with certainty and success involves practical self-fertilization on the part of the crop being improved, and this question has been studied by using the colour of the husked grain as an index. The results of several trials with red and white paddies from different parts of the province, and containing different proportions of red and white grain, indicate that 2 per cent. is the probable maximum of crossing. By this is meant that if two pure lines of red and white paddy are sown together mixed in equal quantities, the maximum percentage of plants which will be heterozygotes in the next generation will be 2 per cent. of the whole. Incidentally, it was ascertained that the red coloration of the grain is a simple Mendelian dominant to white, the offspring of the F_1 generation, giving reds to whites in the ratio 3 to 1. Such a small crossing percentage indicates that the pure line method may be adopted without any hesitancy. Cultivators' varieties are so mixed that a large basis for choice and selection is provided by a single field, and hybridization by artificial means need only be resorted to in very special cases, and for the solution of very particular problems.

As indicated above, the desire of the miller is for a bold round grain possessing a high degree of resistance to breakage in the milling process. On the other hand, the finest edible rices in India and Burma are those possessing a long, thin, cylindrical grain. Hence cultivators frequently divide their crop into "Wun-Sa" and sale paddy. The frequent mixing of these two types of grain constitutes a serious grievance to the merchant.

The number of types is, as in other countries, excessively large. They are distinguished by different shapes of grain, of the empty glumes, of the glume tip and awns, and by differences depending on colour combinations in sheathing leaf, stigma, glumes, and seed. Striking types are the handsome purple-leaved, glutinous rices with their long, thin, opaque grain; the so-called winged varieties, in which the outer glumes, usually minute, are prolonged beyond the inner; and the floating rices with bent stems, which are suitable for growing in regions where flooding is common. The variation is also as great in physiological as in morphological characters. Such are earliness of flowering, susceptibility to insect attack, tillering power, standing power, and yield.

It is clear that all efforts at improvement must be strictly based on the demands of millers, and must accordingly aim at the production of pure lines characterized by a small breakage percentage and an absence of coloured grain. At the same time, however, the demand of the agriculturist must be kept clearly in mind, and the above qualities must be combined with heavy yielding capacity, resistance to disease, and adaptation to the available water supply. It is fortunate that the crop does not suffer from any serious fungus attack. Dr. Butler, Imperial Mycologist to the Government of India, has reported[1] rice bunt (*Tilletia horrida,* Tak.), *Cercospora oryzæ*, Miyake, (?) *Entyloma* sp., *Epicoccum hyalopes*, Miyake, *Fusarium* sp., *Metasphæria albescens*, v. Thuem., *Nectria bolbophylli*, P. Henn., *Phoma glumarum*, Ell. and Trac., *Pyrenochæte oryzæ*, Shirai, and *Septoria* sp., as commonly found in the ears, stalks, or leaves of rice in Lower Burma, but in no case doing any material damage, being chiefly present on plants weakened by insect attack. The latter constitutes the most serious source of damage, and the various attacks of insects are known collectively to Burmans as "gwabo." They are mainly due to boring and cutting grubs of species of *Schœnobius* and *Nonagria*. This insect attack, which manifests itself in sterility and emptiness of the glumes, is kept in check to a certain extent by the practice of burning the stubble which is common in Lower Burma. On only one occasion has the present writer seen a crop completely destroyed by this cause, and that occurred in the newly opened Mon-Canal area in Upper Burma. So far attempts to obtain insect-resistant lines by selection have not given any positive results.

The very serious eel-worm disease of Bengal, known as ufra, and due to a species of *Tylenchus*, has, fortunately, not yet made its appearance in Burma.

The intra-varietal selection for "yield" forms one of the most interesting and important aspects of rice improvement. At the Hmawbi Station the Svälof method of comparing a large number of pure lines taken at random, and selecting the heaviest yielding of these, has been adopted. In the case of each variety to be improved it was determined to begin the first year with 1,000 parent ears selected at random, and planted out widely enough to enable the habit of each individual plant to be seen. At harvest a few of the largest and most vigorous plants were first singled out, and then every tenth plant at

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[1] "Diseases of Rice," *Bulletin No.* 34 *of the Agricultural Research Institute*, Pusa, 1913.

random, thus giving in all about 100 cultures to compare in the second season. The object of this was to determine whether by so spacing the plants "yield" quality in a parent plant could be detected by the eye. The results have been negative. Many of the apparently superior plants of the first year have proved in the second year to be splitting cultures due to natural cross-fertilization, their exuberance of growth and tillering in the first season being simply the well-known phenomenon associated with all first crosses. Hence this preliminary work has been abandoned, and in future comparison will be made directly between the lines. At the moment of writing the results are not available, nor has the soil error been determined. The determination of the latter for both nursery and transplanted field is an essential to accurate work of this kind, but is only made possible when a sufficiently large stock of a single pure line culture has been obtained. It is hoped that this determination will be completed during the present season.

When the degree of probable error has been determined it will be possible to say whether intra-varietal selection for "yield" is an easy possibility or not. So far as is known, the literature of rice cultivation gives no definite data on this question. It abounds in varietal tests and trials in which the variety is taken as the unit and compared with other varieties. The question, however, which concerns us at present is whether a variety which is specially adapted to the trade requirements in the character and quality of its grain, but of low yielding power, can by selection among its lines be transformed into a type which will satisfy the demands of the agriculturist as well.

THE PRODUCTION OF MAIZE, WITH SPECIAL REFERENCE TO SOUTH AFRICA.

By JOSEPH BURTT-DAVY, F.L.S.

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Importance of the Maize Crop.—It is perhaps not generally realized that the world's consumption of maize is greater than that of wheat, actually 447,000,000 bushels more, while it takes only one-half of the acreage laid down to wheat to produce the same yield of maize. At the same time the foliage and stalks of the crop yield a large quantity of highly nutritious stock food; it is claimed that there is no farm crop grown which produces a heavier yield per acre of stock food than maize.

The importance of this crop as a source of food for man and his domestic animals, and also as a source of supply of alcohol, starch, glucose, dextrine, corn oil, glycerine, cellulose, and other commercial products can scarcely be over-estimated. The world's annual consumption of maize is about 1,100,237,180 muids (of 200 lb.), *i.e.*, 3,928,947,000 bushels; of this the European Continent absorbs something like 43,200,000 muids, and the demand is constantly increasing, as new uses for this cereal are being found. The European markets are at present supplied chiefly from the United States, Argentina, and South-east Europe. The local consumption of the first-named country is steadily increasing, and its surplus is decreasing (it has lately been a large buyer from the Argentine), while the European markets are looking out for fresh sources of supply. The climatic conditions which control the distribution of the maize crop are such that there is no unbroken area of suitable land of any size left in the United States and Canada fitted for maize growing.

At present the whole of the African Continent produces only about 1 per cent. of the total world's production, while the United States of America contributes 75 per cent. But there is no reason why South Africa should not contribute a much larger percentage; in fact, as a field for maize growing, British South Africa is the most suitable and most promising undeveloped area of equal size in the whole world.

We have an ample average rainfall, at the right season of the year, and phenomenally favourable winter weather for the natural production of the quality of grain most suitable for shipment, whereas Argentina is always hampered by her autumn rains, which often seriously damage the crop. Owing to the dryness of the winter over the greater part of South Africa, the farmer is able to continue harvesting and shelling in the field up to the very day when he starts planting the new crop; in this respect he has an enormous advantage over the farmer in either North or South America. The percentage of grain which is damaged by the weather is exceedingly small; the moisture-content of the grain exported (without artificial drying) is some 4 per cent. lower than that of the American-grown article. South Africa has, and is likely to have for many years, an excellent local market for a large part of her crop, the Rand mines alone taking over 75,000 tons (Colonial) per annum. Because she owns her own railroads she can carry her surplus to the coast ports at cost. With this great advantage in her favour, South Africa has good reason for optimism as to the future of her maize industry; there is good ground for the prophecy that she is to become the maize granary of Europe.

Our present average yield is low (not over 4 muids —14 bushels—per acre), but good farmers are producing an average of 20 muids (72 bushels) of maize per acre. I expect to see still better yields as our maize lands get into better "heart" with more humus in the soil; in fact, one crop of the present season is reported to average 28 muids (100 bushels). The present low average yield is considered just about to cover expenses of production; if the yield were more than doubled, therefore, maize growing should pay handsomely.

We exported 1,750,000 muids of maize grain in 1910. I believe that the Transvaal alone will be able to produce without difficulty, and will produce in the near future 35,000,000 muids per annum.

Maize will always be the staple cash crop of South Africa. As its value for stock food becomes better appreciated the local demand will increase, and in this connection Earl Grey's recent prophecy (at the "South African Dinner," 1913) of a coming shortage of the world's beef supply is suggestive. Maize and cattle farming go hand in hand.

Distribution and Climatic Requirements.—Though the maize plant is not known in a truly wild state, *i.e.*, reproducing itself spontaneously from self-sown seed, it appears to have originated on the tropical table-lands of northern South America, probably New Granada, at a considerable altitude (probably above 4,500 ft.). It is now grown as a staple grain crop in the following countries:—

North America:
- United States.
- Mexico.
- Canada (Ontario and Quebec).

South America:
- Argentina.
- Uruguay.
- Chile.

Europe:
- Austria.
- Hungary.
- Croatia-Slavonia.
- Bosnia-Herzegovina.
- Roumania.
- Italy.
- Russia.
- Northern Caucasia
- Serbia.
- Bulgaria.
- Spain.
- Portugal.
- France.

Asia:

British India.

Africa:

Egypt.
Sudan.
Algeria.
British South Africa.

Australasia:

New South Wales.
Queensland.
Victoria.
Western Australia.
New Zealand.

Maize is also grown, but to a lesser extent, in Central America, the West Indies, Brazil, Paraguay, Bolivia, Peru, Uganda, British East Africa, Nyasaland, Madagascar, Mesopotamia, Ceylon, China, Japan, the Malay Archipelago, and New Caledonia.

The geograpical distribution of maize as a profitable farm crop is very markedly restricted by climatic conditions, *e.g.*, temperature, sunshine, amount and incidence of rainfall, and the length of the growing season. Topography and the character of the soil, latitude and altitude, are also important factors. Only where these several factors are suitably combined does the culture of maize become commercially successful; the absence of any one of them may limit production on a large scale.

It is important that we should understand the relation of these several factors of the maize crop. Speaking broadly, the most favourable conditions are long humid summers, hot days and warm nights during the growing season, comparatively heavy, intermittent rains, with abundance of clear sunshiny weather between. Maize is essentially a tropical and sub-tropical crop, being an annual, summer-growing plant, sensitive to frost. But within the limits of the tropics and sub-tropical zones its distribution is also limited. The desert and the tropical jungle are alike unsuited to its commercial production, the former from lack of moisture, and the latter from lack of sunshine; maize is essentially a crop of the open grass-steppe country at comparatively high altitudes. But here again we find its distribution limited; in South Africa it does better on the uplands above 3,000 ft. than at or near sea-level, where the growth of rank weeds which over-top the maize plant interferes with the development of the grain.

Altitude affects the growth of crops indirectly, as it influences length of season, temperature, precipitation of moisture, depth and richness of soil, etc. The altitude at which the maize crop can be grown successfully varies from sea-level to 10,000 ft., or possibly more, latitude compensating altitude. In the United States 82 per cent. of the crop is produced between 500 and 1,500 ft. altitude.

Temperature.—Eighty-eight per cent. of the United States crop is grown between the July isotherms 70° and 80° F., whilst the actual highest yields have been obtained between July isotherms 75° and 80° F. The average temperature of the maize belt of Argentina is 62·3° F., and the belt lies between summer isotherms 71·6° and 78·8° F., and annual isotherms 59° and 68° F.

The average mean monthly temperatures for the four growing months (November to February inclusive) in the Transvaal over a period of seven years are: Pretoria (4,500 ft.), 70·28°; Vereeniging (4,700 ft.), 69·29°; Bethal (5,580 ft.), 64·68° F. Though we have abundant proof that good maize crops can be grown where the nights are uniformly cool, as in the Transvaal, it is probable that warm nights tend to heavier yields per acre.

Low soil temperature retards germination and subsequent growth. Maize lands should be well drained in sub-tropical climates, for wet soils are usually cold.

Rainfall.—As compared with many—I think we may safely say, most—farm crops maize requires very little moisture, especially when we consider the weight of green material produced by it; King, of Wisconsin, found that it required only about half the rainfall necessary for a crop of oats or clover. But the maize plant requires a considerable amount of water at certain stages of growth, especially up to a height of about 6 in., and again at the time of flower production.

At the Illinois Experimental Station a rainfall of 13 in.

during the five growing months produced 9 muids (1,792 lb.) of dry maize grain per acre; the following year 22·5 in. during the same period produced 26 muids (5,264 lb.); the results indicate that the increase of 17 muids per acre was due to the additional 9·5 in. of rain, or 1·8 muids increase for every additional inch increase of rainfall. American investigators consider that a rainfall of 11·5 to 12·0 in. in the three summer months—June, July and August—or 15 in. during the four growing months, is adequate. During the season just over I have successfully grown about 400 acres of maize with the following rainfall:—

	In.	In.	In.
November	0·55	0·55	
December	1·71		
January	2·58	8·04	= 11·86
February	3·75		
March	3·27	3·27	

The crop is light—possibly not more than 5 muids (18 bushels) per acre—but the quality is excellent.

Improvement by Breeding.—The maize plant is monœcious and anemophilous. As is to be expected, therefore, existing strains are extremely heterozygous. It therefore lends itself readily to improvement by (1) selection of improved cross-bred strains, and (2) further crossing. Great improvement has been effected in the United States and in South Africa, both in yield and quality, by these means. Much remains to be done, especially in increasing the world's total production, by developing new breeds adapted to regions which are not yet producers of maize on a commercial scale. By the development of earlier maturing strains the United States has pushed maize growing northward into the States of North Dakota and Minnesota, and it does not seem impossible that a breed might be raised which would produce a commercial crop of grain in the South of England. Miller (" Gardener's Dictionary ") mentions a variety of maize cultivated in 1562, which " ripens its grain perfectly well in England in as little time as barley."

Soils.—Maize can be grown on almost any kind of soil suited to the production of other farm crops; it need not be as rich as the soils required for some crops, but to secure the best results the soil should be moist, but well drained. It should also be of good depth. Maize is sensitive to variations in soil, but perhaps mainly as these affect soil moisture. A crop which gives such a heavy yield as maize must necessarily reduce rapidly the fertility of the soil. The problem of the maintenance of soil fertility is therefore one of the most important for the maize grower.

South Africa must avoid the mistakes made by the farmers of the Southern States, where, Hopkins tells us, thousands of acres of land are practically ruined from an agricultural point of view after but 200 years of farming. Contrast the condition of England to-day, where we are told "the older England grows, the richer become the average soils; cases of impoverishment are few and far between."

If proper steps are taken to maintain the crop-producing power of the soil, maize does not prove an exhaustive crop. The amount of soil elements removed is small in proportion to the amount of foodstuff produced; large quantities of organic matter are produced which, when fed to live stock, make large quantities of organic manure to return to the soil; the intercultural tillage required by the maize crop is beneficial to the soil.

Soil fertility is maintained, and even improved, by (1) green manuring; (2) use of farmyard manure; (3) use of artificial fertilizers. As one of our practical maize growers says: "It pays, and pays handsomely, to fertilize," and this I can confirm by actual proof.

Treatment of the Crop.—Broadly speaking, we obtain the best results by the following methods, altered to suit varying conditions, viz.:—

Ploughing fallow or new lands in summer as soon as possible after the work of planting the new crop has been completed. This ground is reploughed in March or April. New ground is ploughed first to a depth of 6 in.; the second ploughing is made as deep as the plough will go (9 to 11 in.). The disc-cultivator or Martin's cultivator is used to reduce the surface, and the latter to clean out quick grass (*Cynodon dactylon*). Weeds are fatal to successful maize growing, and the aim in all our operations is to reduce the weed crop as economically as possible. The zigzag harrow is used after every considerable rain to break the soil crust or kill germinating weeds. Two or, if possible, three crops of weeds should be killed in this way before planting.

Maize seed is drilled in with a two-row American "planter," which places the grain in rows 2 ft. 6 in. to 3 ft. 6 in. apart, and drops the seed at varying distances of 12 to 18 in. In the Transvaal we find that 3 ft. 6 in. between rows and 1 ft. 6 in. to 2 ft. in the rows is a suitable distance for the ordinary breeds.

Time of planting is regulated by altitude and time of arrival of spring rains. On the high veld (5,000 to 6,500 ft.) October is the safe month for most breeds; in the middle veld (4,000 to 5,000 ft.) November to middle December is, broadly speaking, more suitable; in the upper and lower bush veld (below 4,000 ft.) December to middle of January is the usual time for planting, because the rains usually begin later.

Immediately after planting we harrow with the zigzag harrow, and try to harrow off two crops of weeds before the maize plants get too large; the harrow can be used until the crop is 6 in. high. Then we begin to cultivate, using one of the numerous American walking cultivators which straddle the row, drawn by two muzzled oxen or mules. I find the duck-foot type of cultivator superior to the disc type for this purpose. Our object is to keep on with this cultivation continuously until the plants are too tall to be straddled safely. Then we begin with adjustable tooth cultivators between the rows, drawn by a single ox or mule. This work is maintained continuously until the ears on the stalk become so large that there is danger of their being broken off by the animals in passing.

The object of this constant cultivation is: (1) The retention of soil moisture and proper aeration of the surface soil, and (2) the destruction of weeds. It is this constant cultivation which is the secret of success in maize growing. As a Yankee farmer once quaintly but very truly remarked: "There ar'nt but one way o' raisin' corn: cultivate, and cultivate, and keep on cultivatin'."

Harvesting.—Harvesting is usually done by hand in South Africa owing to the abundance of cheap native labour. Most of the crop is left to ripen and dry off on the stalk; the ears are then pulled by hand, the husk being left on the stalk; or the ear and husk are taken off together, the husk being removed with a combined husker and sheller. The grain is then bagged for milling or export, in bags of 203 lb. gross, the standard weight being a muid of 200 lb. net.

A few farmers have adopted the plan of cutting and stooking the stalks before the ears are dry, and this method will doubtless be increasingly practised, as it results in a higher feeding value for the stover.

Diseases.—Broadly speaking, the South African maize crop has comparatively few diseases and pests. The principal diseases are: brown rust (*Puccinia maydis*, Bereng), red rust (*Puccinia purpurea*, Cooke), maize smut (*Sorosporium reilianum* (Kühn), McAlp.), dry rot (*Diplodia zeæ* (Schw.), Lév.), and leaf scorch (*Helminthosporium turcicum*, Pas.).

Weed Pests.—The most pernicious non-parasitic weed pests with which we have to contend are: Bermuda quick-grass (*Cynodon dactylon*) and uintjes (*Cyperus esculentus* and *C. rotundis*). We have a parasitic weed pest peculiar to South Africa: *Striga lutea*, Lour., called witch weed, because it is supposed by the natives to bewitch the maize fields. It is a troublesome and dangerous pest in the warmer parts of the country, and seriously reduces yields. We are learning how to deal with it.

Animal Pests.—The Chacma baboon (*Papio porcarius*), monkeys (*Cercopithecus pygerythrus*), the jumping hare (*Pedetes caffer*), the reed rat (*Thryonomys swinderenianus*), a small jumping rat (not identified), the porcupine (*Hystrix africæ-australis*), the African rook (*Heterocorax capensis*), the blue crane (*Anthropoides paradisea*), and the guinea fowl (*Numidia coronata*), all do some damage to the crop and tend to reduce yields.

Insect Pests.—More damage is done by certain insect pests; of these the most troublesome are: (1) The cut worms, larvæ of several species of *Agrotis;* (2) the stalk borers, top grubs or tassel worms, larvæ of *Sesamia* *fusca*, Hampson, and of another moth; (3) the striped beard-grub or ear worm, the larva of the moth *Heliothis armiger*, Hubn.

With good farming (*i.e.*, good cultivation, winter ploughing, rotation of crops, and fallowing) these pests are not proving a serious menace. The stalk borers are perhaps giving most trouble, but the use of trap crops is proving a useful preventive. Weevils, the angoumois grain moth, and rats and mice give the usual amount of trouble with grain stored in bags.

Varieties and Breeds.—The varieties *indentata* (dent maize) and *indurata* (flint maize) are most largely grown in South Africa, with a tendency to discontinue the flints owing to lower yield. The varieties *præcox* (popcorn), *erythrolepis* (flour corn), *tunicata* (pod corn), and *rugosa* (sugar maize) are also grown to a limited extent.

Of dent maize Hickory King is the breed most extensively grown in South Africa. It is a white dent. Other white dents grown are: Louisiana or 10-row Hickory, Hickory Horsetooth or 12-row Hickory, Iowa Silver Mine, Ladysmith, Natal White Horsetooth, Boon County, and Salisbury White.

The principal yellow dents are: Yellow Horsetooth, Chester County, Eureka, Yellow Hogan, Golden Beauty, Golden Eagle, Reid, Minnesota Early, and Leaming.

Of flint breeds 8-row Botman, Cango, Wills Jehu, and North Dakota are principally grown. Repatriation and Bushman are rarely met with.

Commerce.—It is, unfortunately, impossible to give the present South African production of maize owing to the absence of reliable statistics. We have exported as much as one and a half million muids (5,350,000 bushels), and local consumption is large: some three-quarter million muids (2,670,000 bushels) are consumed on the Witwatersrand for feeding the natives employed on the mines. The production of the Transvaal in 1908-9 was 1,437,834 muids (5,133,067 bushels).

The Union Government has wisely fostered the export of maize by providing cheap rates from inland centres to the coast (10s. per Colonial ton), and by arranging with the steamship companies to carry the grain to

European ports for about 11s. 6d. per ton, or 2s. 6d. per muid from inland station delivered on the wharves at London. From time to time the policy of the Government in fostering the export trade has been criticized on the ground, sound in itself, that it is better to feed our maize crop than to export a raw product. But this objection is based on less than a half truth; while admitting that it is better to feed the crop locally than to export, one must not forget that the export trade has done more than anything else to develop the maize industry of South Africa by (1) steadying the local market and thus preventing prices from dropping below payable figures; (2) encouraging the greater production of maize; (3) bringing capital into the country at a time when we could not produce enough beef, mutton, or wool for export.

The rapid development of the industry may be gauged by the fact that whereas in the year 1904-5 the Transvaal alone imported maize to the extent of 375,147 muids (valued at £218,659), in 1906 she exported 3,716 muids and in 1910 exported 759,830 muids, while all the time her local consumption was rapidly increasing.

Maize for Stock Food.—Valuable as is the maize grain in the arts and manufactures, and important as an export trade is, it must not be forgotten that the primary value of the crop is as a source of food for stock. Not only is the grain a valuable stock food, but the stalks and leaves make a most palatable and nutritious stock food, either as silage, hay, or stover. With a threatened shortage of meat in the more densely populated parts of the world people are seeking new countries of supply, and those countries which can produce good maize crops are likely to come to the fore as beef producers. In the United States, the home of maize, the chief use of this crop is as food for domestic animals. "In connection with grass, it is *the* meat-producing material of the United States. The wonderful development of our pork industry is directly related to our maize crop. . . . The ears of maize are the natural food of the civilized hog." (Hunt).

Machinery.—There is a good and rapidly growing market in South Africa for maize-growing implements, such as are manufactured in the United States and Canada. Also for shellers, nearly all of which come from England. Reapers, shockers, and binders are not yet in demand, but the demand is growing as the farmers get more capital to spend on implements. Nearly all our maize planters and cultivators are made in the United States. Every year the merchants underestimate the demand for planters owing to the astonishing increase in their use and in the acreage planted. At the beginning of the planting season it happens, year after year, that one cannot get a single planter of certain favourite makes at any place in South Africa. I know one small country firm which sold fifty-two maize planters in one season, which was more than they had sold in the preceding seven years! This will give some idea of the rapid progress being made. There is great need for a smaller and cheaper husker and sheller.

The preparation of maize silage is steadily on the increase, and the demand for silage cutters and for shredders is keeping pace with it. These facts should be brought to the notice of the English, Canadian, and Australian manufacturers.

Bulk Handling.—If the Government would take its courage in both hands and adopt the bulk handling of maize, as so ably recommended by Sir Thomas Price in his Report of 1911, it would give a great impetus to the export trade.

We use 2½ lb. "A" twill jute grain bags, imported from India, for the export trade, and "B" twill for the local trade. The cost of these bags to the farmer has increased 100 per cent. in the last five years, and this fact may force us to adopt bulk handling. Indian grain bag manufacturers would be well advised to consider this point and to try to keep our grain bag trade. It is claimed that this increase is due to the shortage in the supply of jute, a point which should be considered by planters in regions where jute can be grown profitably.

I am fully alive to the fact that it is better to make our maize walk to market on four legs than to export it in the form of the raw article. This, however, must come naturally with increase of immigration, smaller holdings and increase in dairying, cattle fattening, and pig raising. In the meantime, and for some years to come, local production will be greater than consumption, and the export trade will benefit the agricultural community by bringing capital into the country.

Direct Shipment.—Our maize trade would be in a much better position if we had direct shipment to Liverpool, Manchester, Waterford, and Glasgow; at present nearly all our grain is sold through London, and transhipment to those ports adds to our cost what might otherwise be gained by the competition of these markets to secure our grain. The merchants at the ports named are very anxious to handle our maize. With the ports competing, it seems to me probable that our trade would be diverted from the Continent, which now consumes more than Great Britain. London brokers admit that theirs is the cheapest grain market in the world, and as long as we are solely dependent upon them we cannot secure such good prices as would be the case if we could ship direct to other ports.

It would be greatly to the advantage of both South Africa and the other Dominions of the Empire if the commercial bodies of the latter could be made aware of the fact that South African maize is *the best in quality and condition of any produced in the world.* An export trade with Australia has already commenced. India might take large quantities of our maize in exchange for the more expensive articles of commerce which she produces and we do not. The climatic conditions of Canada do not allow her to produce more than a fraction of the maize which she requires for manufacture and stock food, and I understand that the direct lines of steamers between Cape Town and New York and Canadian ports could carry our maize for less than the tariff charge on some 1,500 miles of rail, over which United States maize is carried from the "Corn Belt" to Toronto, Montreal, or Quebec. Egypt also, though a producer of maize to some extent, is also a buyer, and we might perhaps secure her trade if she knew what we produce.

We can produce maize probably more cheaply than

Australia, India, or Egypt, because it is grown on relatively cheaper land—land which is at present much cheaper than that in the "Corn Belt" of the United States of America. Land in India and Australia suitable for maize growing is too valuable, because it can produce other and more expensive crops, which we cannot produce profitably on our maize lands.

Need for More Farmers.—The land is crying out for men—capable, trained farmers with £1,000 to £1,500 capital. Opposition to immigration is passing away. At the Transvaal Agricultural Union Congress, a resolution favouring immigration was passed on the evening of April 2, 1914, the first time in the history of the Union that such a resolution could be passed, though frequently tried. We need good formers of the yeoman type—from England and Scotland. For the development of the Low Country, where cotton, tobacco, and sugar-cane can be grown, we need a few hard-working settlers from the United States, accustomed to deal with malarial fever, and therefore not afraid of it.

Profits in Farming in the Transvaal.—I doubt whether there is at the present moment any country in the world where capital put into the development of agriculture can be so rapidly doubled as in the Transvaal. I know a case where a young man cleared £1,500 the second year of farming on the Transvaal High Veld. I know other cases where farmers have bought their farms outright after paying rent for six years, and in the meantime have completely fenced, camped, built farm buildings and houses, and got together herds and flocks, besides planting shade trees, wind-breaks, and orchards, and have lived plainly but comfortably on the proceeds of their farms. In three such cases the men started with only £1,500 capital, and paid £90 per annum rent. Their crops were maize (the staple), potatoes, and teff grass, and they supplied milk to Johannesburg, about 100 miles distant.

We have excellent land, as cheap for its potential value as any in any other healthy part of the world; as fine a climate as any in the world, where our men and our stock can work on the land from one year's end to the other; we have an excellent railroad service, low export rates, and an assured and growing market for all the maize, meat, and wool we can produce.

For further information on the subject of maize growing I must refer my readers to my recently published book, "Maize: its History, Cultivation, Handling, and Uses" (London: Longmans, Green and Co., 1914).

SUGAR.

THE SUGAR-CANE IN INDIA.

By C. A. Barber, Sc.D.Cantab., F.L.S.
Government Sugar-cane Expert in India.

The indigenous canes of India differ so greatly from those usually met with in the tropics that a competent observer has suggested that they are of different descent, and have arisen from separate species of wild Saccharum. It is certainly a matter of small difficulty to distinguish between the native canes and such introductions as are occasionally met with throughout the country. Practically, the whole of the thicker canes of North India, termed locally "Paunda," are foreign, being only grown under special conditions near large towns, heavily manured, carefully tended, and used only as a fruit, pieces of them being sold in the bazaars at a small price for chewing. Here and there records survive of their introduction into the country by some enterprising officer, in other cases the names by which they are known indicate a foreign origin, while, in many, all traces of their importation have disappeared, and we are dependent on their morphological characters and obvious unsuitability for general cultivation as proofs of their foreign character. In the present note I propose to leave out these introduced canes altogether and deal exclusively with the native canes of India, with the object of impressing their characters upon those who have not had the opportunity of seeing them.

As regards the growth of the sugar-cane, India may be divided roughly into two great regions: Peninsular India and the sugar-cane tract of North India. Not that sugar-cane cannot be grown in India wherever water and warmth are available, but these two great divisions account for 99 per cent. of the crop.

(1) *Peninsular India.*—The Tropic of Cancer crosses India between the mouths of the Ganges and Brahmaputra and that of the Indus; south of this line you have Peninsular India, which is thus wholly within the tropics. Sugar-cane in this region is grown chiefly in Madras, Mysore, and Bombay. With few exceptions thick canes predominate, many of them having been introduced recently by the Agricultural Department; but there are also a number which have been in the country for many years. Some of the latter have undoubtedly degenerated in the course of years, and it is thus more difficult sometimes to distinguish them from the local "desi" canes than is the case in North India, especially as the latter are naturally thicker in the south. The yields in the field are often large, not far, indeed, behind those in most sugar-cane growing countries. Occasionally great care is taken in the cultivation, and comparatively heavy doses of manure are given in the form of oil-cake, with very satisfactory results. But, taking the whole region together, it is comparatively unimportant, and the acreage, possibly reaching 250,000, does not constitute one-tenth of that under this crop in India. A little of the cane grown in the Peninsula is manufactured into sugar; a larger quantity is used for chewing in the towns and more populous country districts; while the great bulk is crushed locally in bullock-driven mills and made up into jaggery, an impure, soft-brown sugar, with much glucose and impurities of various kinds, used as food by the people all over the country.

The growing of sugar-cane in this southern region is limited by the amount of water available and the quantity of paddy grown. The fields are small and isolated, often less than an acre in extent, and the crop is usually planted in rotation with wet paddy—that is, rice grown in mud and constantly immersed during the greater part of its life—a rotation which always appears to me to be of a very unsatisfactory character. The difficulty of obtaining land in a compact block among a number of small holders is one great bar to any extension, from the factory point of view, of sugar-cane growing in this region, and, added to this, it must be remembered that paddy is a necessary food, is extremely easy to grow, and is practically unaffected by disease, and, at present prices, the crop is a very profitable one. The ryot naturally prefers the small expense and labour needed in growing paddy during part of the year to the greater cost and constant labour for the whole twelve months for sugar-cane, especially when there is some doubt in the latter case as to the success of the crop reaped. The need of capital and the uncertainty of the outturn, because of possible drought or disease, make sugar-cane cultivation more of a venture. When any cultivator decides to embark on this enterprise he is regarded by his neighbours as a man of substance, with sufficient means to indulge in a certain amount of speculation.

(2) *The North Indian Sugar-cane Tract.*—This is not in the tropics. It consists mainly of a stretch of 1,000 miles of country south of the Himalayas, varying from 100 to 300 miles in width, extending from the Brahmaputra to the tributaries of the Indus, from Bihar and Assam on the south-east to the Punjab on the north-west, constantly becoming colder in the winter as one proceeds, until the incidence of frost is a regular thing. The region includes the whole of the northern part of the Gangetic plain. The soil is fine, soft, stoneless alluvium, uniform to a great depth, there being practically no distinction between soil and subsoil. It is very easily permeable by water, and, near the Himalayas, is well supplied with water at no great depth, the water table sinking steadily as we leave the mountains. The submontane tract thus needs little irrigation, but further south there is a vast network of canals, the crop is always irrigated, and the sugar-cane occupies the lower portions and wheat the higher. This North Indian tract accounts for from two to three million acres of sugar-cane; thus far exceeding the Peninsula in importance.

The climate is, however, better suited for wheat growing than for sugar-cane, and it is with an undoubted shock that a traveller, accustomed to the cane-growing countries of the tropics, views the first cane field in North

India, the crop being stunted and grass-like in comparison with those of Java, the West Indies, and Mauritius. It is, in fact, extremely unlikely that our traveller would recognize the crop at all. The canes are thin, short, or moderately tall, but never equalling the tropical luxuriance; they are hardy against drought or waterlogging, and are consequently often grown in unsuitable places; the juice is fairly rich and contains little glucose at ripeness, but it is scanty, and much of it is absorbed at the mill by the mass of fibre which the stalks contain; the rind is hard and the leaves are narrow, often being less than an inch across at the widest place.

The limiting factor in cane-growing in South India is water; in North India warmth. The latter is insufficient for tropical canes to ripen, and those that are grown, being merely used for chewing, cannot hold their own in purity with the local cane. The latter have for centuries been adapting themselves to the local conditions and make the most of their opportunities, as will be seen from the following: While the growing period in South India is twelve months of the year, provided canal, well, or river water is available, that in North India is strictly limited. Irrigation or a large quantity of rain or water in the soil is necessary for sugar-cane growing in India, for, in place of the rains which give showers every month in the West Indies, there are four or five months during which no rain falls, and without artificial watering the cane would inevitably die.

In North India there is often a considerable period of time between reaping and sowing, and various methods are adopted to keep the seed. In the Punjab it is stored in great mounds of earth, very like the similar mounds used in Europe for storing mangolds. Rain is usually absent from India during the first half of the year, so that, although the canes are sown as soon as there is warmth enough for germination, growth during the earlier period is very slow. The temperature, however, rises rapidly until it far exceeds anything experienced in South India or any other part of the inhabited tropics. For weeks it is above 100° F. in the shade, and, towards the end of this period, may reach anything up to the maximum of 125° F. The young plants lead a struggling existence during this period.

The inrush of moist air with the monsoon, which reaches North India early in July, changes these conditions almost dramatically. The period of rains which follows is one of more moderate temperature, abundant water, and rapid, forced growth. The water level rises all over the country until large stretches become practically waterlogged. Sugar-cane, as a plant, is remarkably sensitive to lack of drainage, and most of the better canes of North India have been wiped out during recent years by disease arising from this cause. The thinner canes are, however, very hardy, and commence growing with great rapidity. So rapid does this growth appear to be that I believe that there is nothing equal to it in the sugar-cane of tropical countries. It is specially noticeable in August and September, when the water level begins to fall again, the canes simply shooting up, so as to complete their growth while the temperature is favourable. But in October the rains have largely ceased and the sun has passed the Equator southwards. The air becomes cool rapidly, and soon the temperature sinks so low that further growth practically ceases. Canes measured at reaping time, which occurs from December to March, according to locality, show little difference from those examined in August to September. The canes mature during this period. At harvest the fields are sometimes white and dried up; in the Punjab because of the destruction of the leaves by frost, and in dry places, such as Aligarh, because of increasing drought.

The local canes of North India have adapted themselves to these conditions in a remarkable degree, some of them being even able to resist some degrees of frost; they have the power of growing with great rapidity in an almost waterlogged but permeable soil, and maturing during the cold days between October and December. It will be apparent to all sugar-cane growers in the tropics that their rich, thick, juicy canes with comparatively broad, tender leaves are hopelessly handicapped, and they will not be surprised to learn that such canes do not usually ripen sufficiently for factory use in

Northern India. They are sweet and pleasant for chewing, but the proportion of glucose remains high to the end. And, considering the disadvantages under which even the local canes labour, we are justified, I think, in asserting that the North of India is hardly a suitable climate for the growth of the sugar-cane at all. The ideal climate for sugar-cane is moist, steamy, and, as has been pointed out by someone, generally unfit for the white man to live in.

In view of these adverse conditions, the question naturally arises: "How is it that sugar-cane is grown to such an enormous extent in Northern India?" This question is not very easy to answer. In the first place, jaggery, or gur, as it is termed in North India, is a necessary food, and although sugar can now be brought into the country easily and cheaply, this has not been so always. The sugar-cane has thus become an established crop which it would take many years to eradicate, if one were desirous to do so. In the next place, the cultivation as carried on in North India is extremely simple and inexpensive. While it is not unusual for £10 or even £20 to be spent on an acre in Madras, many of the fields in North India are planted, reaped, and the produce made into gur for £3 to £4; and this figure does not indicate capital locked up, but largely represents the labour of the family and their cattle at a time when they would not otherwise be employed. Sugar-cane in North India is rarely manured. At first sight this would appear to be a direction in which improvement might easily be introduced, but a little thought will show that any attempt to apply the heavy nitrogenous manuring usual in other places would probably prevent the canes from ripening at all in the limited time at their disposal. This fact also sharply limits the possibility of introducing such canes as require this treatment for their growth and maturing. Another inducement to the cultivator of North India to grow this crop is undoubtedly the fact that sugar-cane is almost universally recognized as a crop on which money can be raised on loan. In a way this seriously interferes with good cultivation, because, once the loan is secured, it is obviously not to the advantage of the cultivator to spend any more money on the crop than is necessary to bring it to maturity. And such is the wonderful fertility of this great alluvial tract and the inherent hardiness of the canes that the plants, once fairly started, can fairly well look after themselves, provided their irrigation turn is not neglected. Lastly, it is possible that, as will be mentioned later, the cultivated sugar-cane first arose by selection from wild species growing in North India, and that the improvements noted in the canes of tropical regions are simply due to the greater warmth and moisture obtainable there.

Many efforts have been made in the past to exploit this obvious wealth by starting sugar factories. But in almost every case, until recently, this has been done without due recognition of the peculiar difficulties of the case. Experienced planters have been brought over from the West Indies who have exhausted their energies in a vain effort to force the West Indian practice upon the local canes, often bringing with them favourite tropical canes. Managers have been put in charge with no knowledge of the crop at all. In some cases factories have been started without a sufficiently careful study of the local supply and demand, and have failed because they have been literally starved of canes, unless by paying prices incompatible with successful working. But, with the general improvement in tropical agriculture all over the world, things are commencing to move in the right direction in India. Government is keenly interested in assisting enterprise in sugar-making, and a number of factories have lately sprung into existence with better prospects of success than ever before. Looking at the matter all round, and considering that India has far more land under this crop than any other country, and is also probably the greatest sugar consumer in the world, it appears to be incontestable that a great sugar-making industry may be confidently expected. Besides a very careful study of the local conditions in each case, there are two directions in which improvements may be reasonably anticipated. The class of factory and the kind of machinery used in the tropics may very possibly not be those best suited for the thin North India canes and the local conditions of land tenure, and there is room for considerable research in this direction, as well as in thoroughly investigating the existing native methods of making gur. Secondly, the canes are very inferior in many respects, there being, indeed, indications that they are inferior to those grown a few generations ago, many better class canes having disappeared through red rot. A wide field is opened for research in this direction also, and, of the two, I consider it the more immediately promising of useful results.

The vast bulk of the sugar-cane in India is made into jaggery or gur, but a taste for white sugar appears to be arising. During recent years increasing quantities of white sugar have been imported annually, until the figure is at present not far off 1,000,000 tons. This rising import may be due to the general increase in population, the area under cane not having increased in anything like the same degree, to the greater prosperity throughout the country and its increasing wealth, and to a gradual change of taste, especially in large towns, with a desire for a purer product. It has, I think, been rightly contended that India should produce its own sugar, while optimists have prophesied a time when sugar may be added to the list of Indian exports, such as wheat, cotton, jute, and rice. With an idea of assisting in this direction Government has recently entertained two specialists, one in the United Provinces, to study the question of sugar manufacture and machinery, and the other in Madras to try and improve the canes grown. With the latter of these I am at present concerned.

There are three ways in which the problem of improving North Indian canes can be approached. New and better kinds may be imported from abroad, the local canes may be improved by careful selection, and new canes can be produced as seedlings. I have said enough to show that the introduction of canes from other countries is not a very promising direction of energy. Selection, on the other hand, will be a very slow and tedious process in a plant always propagated in a vegetative manner, and in any case this method would be too slow to meet the present crisis. This leaves us with the third method only.

Raising cane seedlings is not in itself a matter of much difficulty. But, in spite of many attempts in the past, this has never been accomplished in India. The reason for this non-success is not far to seek. It has been unfortunate that almost all the experiments have been tried in North India. Flowering of the sugar-cane is comparatively rare in North India; indeed, it is so uncommon in certain tracts that, when it occurs, it arrests the attention of the cultivators, and they are said to view it as a dire portent. We are informed that instances have occurred where the ryots have left their villages on the appearance of flowers on the cane plants, just as they do when there is a scourge of small-pox, plague, or cholera. Every local superstition in agriculture is worthy of careful sifting, for there is generally a kernel of truth and experience in the most extravagant clothing of imagination. While flowering in the sugar-cane is in many cases undoubtedly a varietal character, it seems to me that it is also largely influenced by climate and surroundings, and there is some reason to assume that it occurs in North India chiefly in dry years. In a country where every year passes with a series of dry months during which not a drop of rain falls, the partial failure of the normal rains is a matter of very serious moment, sometimes spelling disaster. A couple of years ago there was quite a phenomenal flowering of the sugar-cane over the eastern districts of the United Provinces, and it is an interesting circumstance that, but for unexpected rains in November after a prolonged drought, the situation would have been very serious throughout the sugar-cane tract. But even when the canes flower in North India it transpires that the stamens do not open, and even if they did the pollen inside is ill-formed and immature. The climate of the Gangetic plain is too cold apparently for the full formation of the parts of the flower, hence the ovules cannot be fertilized and seed cannot be formed.

In South India the frequency of flowering varies a good deal in different places, but around Coimbatore (a very dry locality) it is a constant feature of the cane fields. A short examination of the cane arrows or tassels in this locality showed that the anthers of many kinds were open, and well-formed pollen grains were seen upon the stigmas of the flowers. A cane-breeding station was accordingly opened at Coimbatore in March, 1913, and a large number of seedlings have been raised there already, besides some in the previous year at the Botanic Garden of the Agricultural College. And the parents included some of the North Indian canes which, it is interesting to note, although barren in North India, produce fertile pollen at Coimbatore.

The first piece of work of the cane-breeding station, that of raising cane seedlings, has thus been successfully accomplished. But the bulk of these (30,000 to 40,000 in number) are from thick tropical parents, and are less desirable for North India on that account. The problem is now reducing itself to a control of the flowering, so that North and South Indian canes can be induced to flower together and crosses obtained between hardy, thin, rapidly maturing canes and rich, juicy ones. Some sixty to seventy varieties of native or desi Indian canes have already been collected at Coimbatore, and series of experiments are being conducted to induce flowering at will, and thus to control parentage on the lines laid down.

The bulk of the varieties of the canes thus far collected fall into a series of four natural groups with a number of characters in common, and some progress has been made in linking up these groups. There are, of course, also a number of isolated canes whose systematic position is doubtful, but large areas in India are still unexplored by the farm officers, and many varieties have still to be collected. These four main groups may be termed Rheora, Pansahi, Nargori, and Chin, after prominent members, and their relative importance differs in the different parts of the cane-growing tract. In Bihar and adjoining parts of the United Provinces the Rheora group is perhaps most widely grown, but a primitive series (Nargori) comes into evidence in poor, unirrigated land towards the hills. In the Punjab, at the other end of the tract, both of these classes are absent, and perhaps 90 per cent. of all the canes grown belong to the Chin group, which, extending into the western parts of the

United Provinces, appears to be unrepresented in the east of these provinces and in Bihar. The Pansahi group extends throughout the cane-growing region, being perhaps at its best in Bihar, and becoming less abundant towards the north-west, until it leads a struggling existence in the Punjab, occasionally being wiped out by frost there and reintroduced with difficulty. The canes of this group are thicker than the others, and its members are more or less intermediate between the thinner, indigenous canes and the thick, introduced ones. They are delicate, require plenty of water, and are liable to attacks of red rot.

It would be interesting, if time permitted, to trace the changes in the size and luxuriance of the canes as we pass from Madras to Calcutta, and along the sugar-cane tract of North India to the Punjab. The canes of Bengal, Assam, and Bihar are often not far behind those of Madras in thickness, and large crops are sometimes reaped. As we proceed north-west the luxuriance constantly diminishes until, in the frost-visited region of the Punjab, the canes are probably the thinnest and hardiest in the world, often under ½ in. in diameter. The rind of these canes is extremely tough and the proportion of fibre very high. In certain districts of the Punjab this is taken into account for the manufacture of ropes and mats, and the prices obtained for these is sufficiently high to make the extraction of fibre of equal or greater importance to the cultivator than that of gur. As the modern iron mill breaks up the fibre very effectively, we have in these districts the survival of one of the primitive mills of India, called the "belna." The thin canes are tied together into bundles of about 100 each, and are then passed backwards and forwards between wooden rollers, by men on each side, for the best part of an hour. The residual bundles of coarse fibre find a ready market for the manufacture of ropes for mhotes for lifting water, and their price has risen considerably during recent years.

The canes of the Punjab are of special interest because of their primitive character, and show very clear relationship with one of the wild Saccharums of the neighbourhood. Most of these canes are of the Katha variety, a diminutive frost-resistant member of the Chin group, and the resemblance of the Katha to the Kahi grass (*Saccharum spontaneum*) is sufficiently close for the cultivators to assert that Katha originally sprang from that grass. Seedlings of *S. spontaneum* selected and raised at Coimbatore have yielded 3 to 5 per cent. of sucrose in the juice. They are perfectly fertile when crossed with North Indian canes, and a number of hybrids have been obtained with 7 to 12 per cent. of sucrose. These facts seem to lend support to the belief of the Punjab ryots, but it is full early for us to frame theories as to the origin of the Indian canes, as there are many more to be collected and studied, and we have little knowledge of the wild Saccharums of the Malay Peninsula.

Considering the variability of the North Indian canes according to locality, it will be obvious that seedlings suitable for one part will not be likely to do equally well in others. The ideal would be to cross local canes with South Indian ones, so that in every case one of the parents would have adapted itself by long acclimatization to the peculiarities of the tract. And the immediate problem is to induce the desired parents to flower at the same time. But even if they do it is by no means certain that crosses can be effected. The flowers are so numerous and small that it is practically impossible to emasculate them, at any rate in sufficient numbers to be economically useful. And we prefer for the present simply to bring the arrows together and then to examine the seedlings for parental characters. And for this to be done effectively we shall have to make a very much more complete morphological study of the sugar-cane than has ever been attempted before.

Many kinds of cane have steadily refused to flower at all. Some produce infertile flowers, and even those which flower do not so do every year. There will thus be small chance of applying Mendelian methods on the new farm. Where possible this line will not be lost sight of, and the main line of work will be to collect parents of known useful properties and attempt to accumulate these properties in individuals by crossing whenever we can induce parents with complementary characters to flower together. In such work any cane with known partial infertility, whether it be of male or female organ, will be of special service. For instance, the Vellai cane, the best Coimbatore variety, introduced many years ago from abroad, has poorly developed stamens and little good pollen. Advantage has been taken of this during the past year, and the flowers have been dusted with pollen of a number of different varieties which happened to be in flower at the same time. We cannot assume that the offsprings are hybrids, however, because Vellai has *some* fertile pollen; we must wait and watch the development of any known peculiarity of the supposed male parent. Such being the present state of affairs, and it being highly desirable to obtain results of some sort as early as possible, crossing, selfing, and all Mendelian work are at present kept in the background; and the old chance method of raising as many seedlings as possible from arrows of good parents and selecting the most healthy of these for further trial and weeding out the undesirables, is being constantly pushed forwards. We are not without encouragement, even thus early, for some seedlings analysed have surprisingly good juice, at least fifty this last year having over 17 per cent. of sucrose and half a dozen over 19 per cent. But we must wait and see whether these good characters remain constant, and we labour under the additional disadvantage that seedlings which give good results at Coimbatore have to be tested further in North India. An exhaustive study has, therefore, been commenced as to the relative behaviour of various canes and seedlings in Coimbatore and in various parts of North India. There is every convenience for this study, because all along the sugar tract a chain of local farms has been opened, part of whose work will be the testing of such varieties as are sent up from the cane-breeding station in Madras.

THE CLASSIFICATION OF INDIAN SUGAR-CANES.

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Any attempt to improve the indigenous canes of India must be prefaced by a thorough knowledge of their characters and the reasons why they vary so much from place to place. Lists have been published from time to time of the varieties inhabiting different tracts or Provinces, but most of these are far from complete, and no attempt has been made to work out their synonymy and the variations of the same cane under different conditions. In this respect, however, the United Provinces stand out from the rest in that, in Hadi's survey of the canes of this region, the distribution of the various kinds has been tabulated in great detail, and valuable notes as to their relationship have been recorded. The canes of certain parts of Bengal, and especially Bihar, have been collected and studied in recent years at the Agricultural College at Sabour, and a partial survey of the Punjab canes has just been completed. In the two last-named cases collections of the different varieties have been maintained on Government farms, and these have proved to be of the utmost value in the attempts at classification detailed below.

But a very brief study of these collections and those at Aligarh, Pusa, the Central Provinces, and elsewhere has shown that many canes, almost identical in character, bear entirely different names, while the same name is sometimes attached to canes of entirely different character. And the various attempts at classification, although often on right lines, have paid little attention to morphological differences, have, in fact, been agricultural rather than scientific, have dealt rather with the general behaviour and appearance of the cane in the field than with definite botanical characters.

Classifications of sugar-canes in other parts of the world with which I am acquainted are of little use intrinsically, and the canes dealt with in them, being thick, juicy, tropical ones, are on a different plane from those growing in India. The classification of Indian canes may thus be regarded as entirely new work. And it has this difficulty about it, that no starting-point has been indicated, and no one has as yet made any careful morphological study of the sugar-cane. In these circumstances, the only method which has suggested itself to me has been to make an exhaustive study of each cane as it has come into my hands, which has naturally resulted in a constantly expanding series of characters, each new cane providing one or two in which it differs from others previously examined. Many of these characters, at first of apparent value, have broken down after the study of further specimens, while others of great use in distinguishing closely allied forms have no general application. Added to this, there is the constant fear that some of the characters are unstable, and will vary according to the treatment of the cane and the locality in which it is grown. Most of the canes thus far studied have been grown under like conditions of soil and climate, and this question of permanence of characters has still to be studied. The results here recorded will, therefore, have to be considered to a certain extent as preliminary and tentative.

The series of Bihar and Bengal canes collected at Sabour have been classified according to their habit and appearance, and this method of grouping them appears to be an excellent one. It is, in fact, a curious circumstance that such features as erectness, the bending of the leaves, the thickness of the stems and length of the individual joints, tillering, the colour of the leaves, the arrangement of the leaves at the ends of the shoots, all of which can be observed in the field in moderately large plots, appear to be among the most constant for the variety. I have been debarred from much study in this direction because of the wideness of the field covered and the shortness of my stay in any one place, and also because the North Indian canes collected on my farm at

Coimbatore do not appear to be at home in their new surroundings. The examination which I have thus far been able to make has chiefly resulted in noting minute differences in the cut canes and series of measurements of the length and thickness of the joints and the size of leaves and leaf sheaths—that is, such characters as can best be observed in the laboratory.

About sixty varieties of canes have been passed in review, some proving to be duplicates under distinct names from different places. It has been possible to separate four main groups very clearly, as they have a number of common characters, while differing from other groups in their distribution and agricultural qualities. These may be called, after their most prominent members, Chin, Nargori, Rheora, and Pansahi.

I propose to deal *seriatim* with some of the characters upon which I have been led to lay stress, using these groups chiefly for illustration, and, later on, to give a brief synopsis of the characters of some of them, in order to indicate the lines on which I am working. I have selected for brief mention the following: habit, colour, joint, bud; and it will become easy to read between the lines and see how complicated and detailed the study may easily become. The difficulty has not been so much to find differences as to select among them those that are likely to be of general use in classification.

Habit.—I have chosen *erectness*, *leaf-endings*, and *tillering* for discussion here.

(1) *Erectness*.—Upon examining the first seedlings obtained (some forty or fifty) it was noted that comparatively few were quite erect, many were oblique, and some were so depressed as to lie flat on the ground. This habit is naturally to be deprecated because, although subsequent shoots become ascending, the plant takes up too much room from the crop point of view. Attention having been thus drawn to this character, it was found that the first shoots of many of the Indian canes are oblique, as in the Cheni and Saretha varieties, while members of the Nargori group are perfectly erect. This character appears to be inherent and permanent as long as the canes are propagated in a vegetative manner—that is, by

cuttings, as is usually the case. When reproduced by seed, however, the matter is entirely different. In seventy seedlings of Saretha, all stages were seen between upright and depressed ones, just as we saw to occur in those mentioned above, which were largely the progeny of Cheni. This oblique character of the seedlings appears to be much rarer among the descendants of the thicker tropical canes, and the parents are usually more upright from the start than Indian canes. The degree of erectness thus seems to be a matter of some importance from the systematic point of view.

(2) *Leaf-endings.*—The youngest leaf or two of a cane shoot are vertical, but they soon bend outwards, and the manner and suddenness of this bending is a useful distinguishing character in the field. Thus, all the members of the Chin group appear to have a sharp, right-angle bend as they pass from the erect position to the broad curve common to all mature cane leaves. By this character you can readily separate Katha, a Chin cane, from Dhaulu of Gurdaspur, to which it is closely allied. In Khari and a number of others the leaves remain straight and erect for a considerable time, giving the whole field the appearance of a mass of bayonets. In Pansahi and many broad-leafed canes the bend is a curve from the start, and it is very quickly realized. Besides these and other main forms there is an infinity of graduations, so that with a little practice it becomes possible to name the cane within a short distance, and in a field of mixed canes to separate the different components.

(3) *Tillering.*—The number of canes arising from one stool is a matter of considerable importance agriculturally, largely determining the closeness of planting and being correlated with the number and thickness of the canes at harvest. Great tillering power, doubtless correlated with the thinness of the canes, is one of the most marked characters of North Indian canes as a whole. In the thinnest canes of the Punjab it is not infrequent for as many as fifty shoots to arise from one system of roots. The thicker canes of the tropics, tillering far less, more than make up for this by the size and weight of the

individual canes, and perhaps no figures or illustrations will bring home the innate differences between these two series of canes better than the following: Calculations made at Samalkota on whole fields gave four canes to each stool of Red Mauritius and only two and a half to Striped Mauritius, but the canes in this part of India are often of an enormous size. One field of vertical canes produced a specimen nearly 30 ft. in length. And yet, compared with the out-turn of the North Indian canes referred to, which possess great tillering powers, the average crop from the tropical canes in the neighbourhood of Samalkota is about four times as large.

Three characters dealing with habit have been mentioned which may be used in classification. There are a great many others which it is not necessary to discuss in this place.

Colour.—Former systems of classification of the sugar-cane have laid considerable stress upon colour of the stem as a character, sometimes dividing the varieties into main groups according as they were green or yellow, red, striped, ashy, etc. But, although colour is of undoubted importance and fairly characteristic, there are insuperable objections to using it as the basis of a main classification. The frequent appearance of colour sports, especially in striped canes, is against it. I have figured a striped cane stool with red, green, and striped canes springing together from it. Then change of colour on transference of a cane from one place to another is not at all uncommon. Some of the local Coimbatore canes, recently transferred to Pusa, in Bihar, have developed a marked claret in place of the normal greenish-yellow. These facts account for numerous cases of canes being met with which are entirely similar to one another except in regard to their colour.

But, in spite of this, the colour of the cane and of the different regions of the joint is of great taxonomic value, and should always be carefully noted. This is also true of blushing on exposure; not only do varieties differ in the degree to which they may be tinged by sun or wind or frost, but the actual colours vary from faint pink or bright cerise to dark, dull green, or purple. And there would appear to be different kinds of blushing. Some canes show delicate shades of pink after being cut, which are not seen in the living canes. The colour of the young stem still enclosed in the leaf-sheaths of the bud is frequently characteristic and different from older parts of the same cane. And the buds, root-zone, growth rings, etc., often show characteristic tinges which help to distinguish varieties.

The leaf-sheaths also appear to be peculiarly sensitive to light and other influences, and assume different colours accordingly. Thus, the Pansahi group always has dark purple blotches on its leaf-sheaths. This is possibly due to the attacks of a definite fungus, for there is no doubt that there is a specific relation between canes and fungi growing on them. Red rot, smut, Cercospora, and many unnamed leaf fungi will attack certain varieties heavily, leaving others growing in contact with them perfectly untouched. The presence of fungi and the coloration caused by them thus becomes a varietal character. The leaf-sheaths of Dhaulu of Gurdaspur turn a clear crushed strawberry on drying which I have not noted in any other variety, and this coloration is only present in young canes, and disappears in the withering sheaths of older canes. There is a fine field for observations here, and I have only mentioned a few of the differences which can be noted in any field.

The Joint.—The most striking part of the sugar-cane plant is its stem. This is the part which has received most attention in the slow selection of the past ages, and it is therefore to be expected that it should vary markedly in the different groups. I have found it convenient to use the term "joint" for the portion of a cane between two leaf-scars or nodes, thus including in each joint one node and the internode above it. The cane is made up of a series of similar joints placed one above another, those at the base being the oldest and passing upwards into successively younger ones until the vegetative apex is reached. These joints vary in character according to their state of maturity, and also with regard to their position on the stem, but we may leave these differences out of consideration here.

The following are the parts of a mature joint in succession upwards:—

Leaf-scar.—The leaves are arranged in two opposite ranks, each joint bearing one leaf. In North Indian canes these leaves usually remain attached after they have withered, but if pulled off leave a scar behind them which extends completely round the stem.

Bud.—In the axil of each leaf there is one bud, so that the buds are found alternating in two opposite rows.

Root-zone.—This is a distinct band above the leaf-scar and partly covered by the bud, from which adventitious roots will be developed if the cane is cut into pieces and planted. The incipient roots are shown as round dots or eyes of a slightly different shade of colour.

Growth Ring.—This is a narrow band immediately above the root-zone, generally distinguished by the total absence of bloom, and often of a special shade of colour. It corresponds with the ring of tissue, frequently swollen, which in wheat enables fallen stems to rise by the one-sided growth of the external tissues.

These parts are all practically at the node. Then follows the main portion of the joint, or the *Internode*, more or lesss covered by bloom, an incrustation or layer of waxy hairs, which plays an important part in the coloration of the cane. The bloom is often present over the root-zone, is absent at the growth ring, and from that point increases in quantity and thickness upwards until, just under the leaf-scar of the joint above, it is condensed into a regular band of white colour termed the *Bloom Band.*

These parts, leaf-scar, bud, root-zone, growth ring, internode, and bloom band, show a number of differences in colour and development in different canes, so that it will be readily understood that a fairly complete classification may be developed from a study of the joint alone. I propose to select the first two alone for detailed remarks.

Leaf-scar.—This is readily distinguishable as a dark line round the cane. It may be accurately horizontal, as in Katha, or descending towards the bud, or the front of the joint, as in Pansahi. In Rheora and its allies it is frequently alternately horizontal and descending in successive joints. The leaf-scar may project as a shelf under the bud, and this part of it is termed the *lip*. In certain forms it is furnished with a close, regular *circlet of hairs*, which form a very marked character. On examining young lateral shoots of any variety, these hairs are seen to be constantly present as a glistening sheath on all the lower joints. In mature canes they vary very greatly according to the variety; most of them have some hairs on the first formed older joints, but they vary very greatly as to the continuance of the hairs upwards on the cane. They are typically present all the way up the stem in all the members of the Chin group. In the Rheora group they are usually present in the basal joints, but soon disappear under the bud as we proceed upwards. In the Pansahi group, on the other hand, they are very poorly represented, and only survive as a few bristles under the bud, rapidly disappearing at the back of the joint. This circlet of hairs is rather characteristic of Indian canes as a whole, comparatively few traces of it being found in the tropical canes I have examined. I have, however, seen it well developed in at least one Barbados seedling. For these and other reasons I have been led to consider the circlet of hairs a primitive character, still appearing in the most primitive forms and on the lower joints of the more advanced, and I have compared it with the divided leaves seen in the seedlings and new branches of Australian acacias and leafless Leguminosæ. It is, in fact, a marked "youth character" and of considerable importance in classification.

The leaf more than completely embraces the stem, and sometimes the ending of the leaf-scar is decurrent for some distance. This ending is shown as a short, dark line obliquely across the node, even passing for some distance into the bloom band below. This decurrence was first noted in a cane called Sonabile, and by its means all canes of this variety were readily picked out at the mill, and a case of wrong labelling was quickly rectified.

The leaf-scar is usually sharply defined below, and is immediately above the bloom band. Occasionally, however, there is a narrow dull zone between the leaf-scar and the white bloom. On examination this zone is found to be pubescent; there are a set of minute hairs which probably prevent the deposition of wax. I have termed this zone the *scar-band*, and it is characteristic of the Chin group. In most cases, however, the bloom passes right up to the leaf-scar, which is then completely devoid of hairs and dark coloured. In the Rheora group this darkening in the region of the leaf-scar is very marked, and a series of dark brown lines is seen drawn across the stem at the nodes; these lines I have termed *scar-lines*. There appears to be some correlation between the circlet of hairs and the scar-band; the two are usually found in company, and where there is a circlet the scar-line is not often sharp or distinct.

I have dealt rather fully with the leaf-scar, perhaps, and do not propose to develop the characters of the other parts of the joint excepting the bud, merely stating that some of them are quite as marked as those mentioned above. I wish, however, to emphasize the fact that, here as elsewhere, the differences are often extremely minute, and it is a source of wonderment to me that they are so constant. Nothing of the kind, I take it, would be found in any series of plants raised from seed.

The joint as a whole also varies in almost every conceivable direction: thickness, shape, ovalness, colour, hardness; the whole cane varies as to the number of joints, their arrangement, the thickness or length of the joints in different parts, top, middle, bottom, and so forth, and the study of these characters connotes an infinity of detailed observation.

The Bud.—Of all the parts of the sugar-cane plant, perhaps the bud is likely to be of most use from a systematic point of view. One is deprived in this plant of the natural resource of the taxonomist, the flower, although, from observations as have thus far been possible, it appears to be certain that the different canes vary both in the form of their inflorescence and the relative development of their male and female parts. Flowering is rare in the sugar-cane, and we are forced to turn our attention to the much less striking variations in the vegetative organs. The bud contains, so to speak, an epitome of the full-grown cane plant, and it is, therefore, natural to look for variation in this part: and this expectation appears to be justified to a considerable degree.

The amount of *shooting* in buds often helps to distinguish different but closely allied varieties. It has even been asserted that the part of the mature cane, whether the base, middle, or top, where shooting occurs can be used as a distinguishing feature. But here, as in all directions, climatic conditions play an important part, and the subject at present requires further study.

The mode of *bursting* of the bud, correlated apparently with its shape, is an important character. It is comparatively easy to determine the point at which the shoot will arise in quite young buds, because of the arrangement of the veins on the scales. Bursting is usually apical in elongated buds, whilst it is dorsal, that is to say, in the middle of the back, in rounded or short ones. In the Pansahi group it is almost always apical, whilst in the Chin group it is typically dorsal. The matter is, however, somewhat complicated by the fact that, in all canes, the lower joints tend more to dorsal and the upper to apical bursting.

The *size* of a resting bud is a fairly constant character for each variety of cane. Those of Pansahi are large, extending even in the resting condition some way beyond the growth ring, while in the Rheora group they are so small that they do not reach half-way across the root-zone. In Chin they are of moderate size, usually cover the root-zone, and reach the growth ring.

The *shape* of the bud also varies a good deal. In some canes they are flat and round, in others bulged and elongated, in some hemispherical and rounded, and, again, in others scale-like and very long, truncated or rhomboid, emarginate or apiculate, that is, indented at the top or extending into a long beak, arrow-shaped or lance-like—in fact, a considerable repertory of botanical terms is needed to describe the various forms of the bud.

The bud may arise in close contact with the leaf-scar, or it may have its base separated from it by a considerable space. If this occurs the part of the root-zone below the bud is usually without eyes or hairs, and often raised as a swelling. This is termed the *cushion* of the bud, and is a marked feature of the Pansahi group, but absent in the others which we are using as illustrations.

Taking a dominant part in the shape of the bud are the *flanges*. I have applied this term to scarious expansions of the two lowest scales of the bud, seated as these are on the right and left sides, and completely covering the other parts. The flanges may be extremely narrow, hardly visible borders, or large auricled expansions; they may rise near the top, in the middle, or at the lower part of the bud; they may hardly project beyond the apex or form a broad platform as big or bigger than the bud itself; they may be rounded above so as to leave a deep cleft between them or united to form a long beak-like process. And these forms are usually more or less constant for the variety, with the proviso that there are minor variations in the different parts of the cane, as in the bud itself. They may, lastly, be inconspicuous as to colour, or dark and shining like the backs of beetles, when they can be seen at a considerable distance.

The *vestiture of hairs* on the bud is of considerable interest. I have divided the hairs into three main classes: *bristles*, *basal patches*, and *minute black hairs*. The former are confined to the flanges and add to the variability of these parts; they are usually long and straight, and generally determine whether the bud may be called hairy or smooth. Their position and relative abundance in different parts of the flanges appear to be more or less definite. The basal patches clothe the lower end of the bud on each side below the origin of the flanges. Typically developed, they consist of a series, on each side, of short, glistening, often curled hairs arranged close together like the teeth of a comb. From their position and appearance, I am inclined to regard them as homologous with the circlet of hairs already mentioned, and their presence or absence and their degree of development generally differs in the different canes. In some canes they are sharply circumscribed, while in others they extend upwards on the veins irregularly, or even pass along the edges, and become continuous with the bristles on the flanges. The minute black hairs are found on the buds of many varieties, and can only be seen with a moderately powerful lens. Sometimes present only about the apex, they are on other buds seen among the hairs composing the basal patches, in extreme cases replacing the latter entirely. Or they may occur all over the base, between the basal patches, in a position where hairs are usually not present. Their presence or absence has been used as a distinguishing character in at least one case of closely allied forms; in Katha they are hardly ever seen, while in Dhaulu of Gurdaspur they are constantly present.

Doubtless other characters of the bud will come to light which may be of use in classification as more canes are studied; but enough have been mentioned to vindicate the assertion that the study of the bud is of considerable utility in separating the different canes.

The leaf, its sheath, and lamina, and especially the various processes which arise at the point of junction of these latter, have produced a considerably larger number of characters than those mentioned for the bud, but to give them in detail would be wearisome in this place. I would, however, point out that all these observations are necessary in a pioneer study of this kind, because one can never tell which character is likely to prove fixed and of systematic value, and which varies under different conditions. With this latter possibility in mind, it will be seen at once that the classification of closely allied forms purely by their vegetative characters is a work of considerable magnitude. These observations merely form the basis on which the scheme of classification is to be raised. It does not seem likely that any one character, or set of characters, can be used in the form of a key for analysing the different varieties. The method of grouping the canes according to a natural system, in which the sections have the greatest possible number of characters in common, appears rather to be indicated. Such a method will also have the advantage of throwing light upon the origin of the different forms and on the gradual changes which have occurred as the sugar-cane has passed from place to place as cultivation has spread.

Let me conclude with a brief summary of the characters of three of the classes of Indian sugar-canes thus far separated out:—

The Chin Group (seven to eight canes noted).—Canes of the Punjab and neighbouring parts of the United Provinces. Very thin and comparatively tall; bending outwards and ascending; with narrow leaves, characterized by a sharp angular bend at the tip when young; rind very hard, canes fibrous, with a small quantity of rich juice; markedly frost-resistant, but affected as a class by smut; circlet of hairs well developed, present more or less all the way up the cane; scar band present; joints cylindrical and uniform, becoming red-brown when mature; root-zone narrow, with two or three rows of regularly placed eyes, flat or thickening upwards; growth ring very distinct, becoming a rich dark brown and very striking in older parts; buds small, rounded, or pointed, reaching the growth ring, often with dark-coloured flanges, bursting dorsally; ligular processes present, short or long.

The Rheora Group (about twenty canes noted).—Canes of Bihar and the western parts of the United Provinces, passing through an intermediate stage to Dhaulu, and thence perhaps to Chin. Not usually present in Chin regions. Canes thick, short, bunched; leaves moderately narrow, curving broadly outwards in a symmetrical bush; less fibrous and more juicy than Chin, and with softer rind; not frost-resistant, and not affected by smut; circlet of hairs soon disappearing, especially under the bud; scar lines very distinct and marked as dark brown lines across the nodes; joints cylindrical and uniform, but becoming bulged above; often mottled red, brown, or pink when mature; root-zone very broad, with widely separated small eyes, the lower row of which often larger, and the upper massed together, flat or thickening upwards; growth ring practically absent, or only faintly discernible by change of colour; buds very small and rounded, usually reaching about half-way up the root-zone, often dark coloured; ligular processes usually present and often long; leaf-sheaths sometimes very long.

The Pansahi Group (eight to ten canes noted).—Delicate canes, widely distributed between Bihar and the Punjab, but chiefly in the western portion of the cane tract. Thicker than the others, belonging to "ganna" class, between the canes of North India and those of Madras, erect, bunched; leaves much broader, bending over in thick masses of foliage; rind soft, cane juicy, and with less fibre; not frost-resistant, and liable to the attacks of red rot; circlet of hairs soon disappearing, excepting a few bristles under the bud; joints zigzag and curved, becoming dark green on exposure; swollen at nodes, ovate-campanulate above the root-zone; root-zone moderately broad, swollen, and often tubercled, thickening bell-like downwards, with two to three rows of large eyes; growth ring narrow and barely marked, except as a constriction of the cane; buds large, swollen, curved, ovate pointed, considerably exceeding the growth ring; bursting apically and with well-marked cushion; leaf-sheaths short and with dark purple blotches; ligular processes absent, as also splits and ivory markings.

These three groups form natural classes, and are very clearly marked off from one another. A relationship may perhaps be traced between Rheora and Chin as mentioned, but Pansahi seems to have no point of contact with either of the others.

Similar summaries of characters have been prepared of many other forms. Among these there are smaller groups and a number of isolated varieties, such as Kanara, Sonabile, Cheni, Naanal, Khari. Missing links will have to be found in order to trace the relationship of these canes, and large tracts of country have still to be explored for this purpose. When this classification of the North Indian canes has been worked out more completely, I propose to turn to the thicker ones scattered over the country and introduced at various periods from tropical countries, but there will be in that case the disadvantage that they cannot be studied in the place where they have been evolved, and, from a cursory view, they appear to differ far less markedly among themselves than do the canes indigenous to India.

The suggestion has been made in another place that the cultivated cane of North India may have arisen from

Saccharum spontaneum, which grows all over the country. There is this interesting fact to record: The wild Saccharum is not constant in minute details of morphology, but varies a great deal, and some of these variations are such as to place it in relation first with one group of cultivated sugar-canes and then with another. These variations in *S. spontaneum* will therefore be carefully studied.

The morphology of a number of seedlings of known parents has been noted, and it will form an interesting inquiry as to how much and in what direction the fixed characters of the cultivated canes vary in their seedlings, and it is hoped that by this study we shall be in a still better position to choose systematic characters of importance and trace the relationship of the different groups.

SUGAR PRODUCTION IN THE NORTH-WEST FRONTIER PROVINCE, INDIA.

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AND

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At the present time the sugar supply of this Province is derived from locally grown cane and imported sugar. The former crop ripens in December, and is crushed during December and January in the villages, and the juice is boiled down to the crude sugar called gur. The season over which the standing crop is available is less than two months, which is too short a period to admit of a factory paying.

Three years ago several varieties of sugar-beets were sown, and of these several specimens were found on maturity to furnish upwards of 20 per cent. of sucrose. The experiments have been extended somewhat during the past two years, and these have shown that the crop grows well and is of fairly good quality. In 1913 the average samples of two crops furnished 14·7 and 14·2 per cent. of sucrose respectively, expressed on the root; the glucose was 0·07 per cent. in each case. Individual roots contained as much as 18 per cent. of sucrose. The present year's crops have been grown from both German and French seed, and average samples of the roots have contained 16 and 14 per cent. of sucrose respectively. The weight of the crops has varied from 10 to nearly 20 tons per acre. Thus the experiments have demonstrated that the crop will grow well, and there is a considerable prospect that an average quantity of 15 per cent. of sucrose might be obtained on the large scale, especially when more experience has been gained as to the best time to sow the seed. There seems to be no doubt that the weight per acre would be equivalent to the European standard. As regards the length of season over which roots suitable for manufacture can be grown, this is the first year in which an attempt has been made to obtain information. Seed was sown fortnightly, commencing on September 20, 1913, and by March 15 the average weight of the roots was about 1 lb., the sucrose was 14·2 per cent. expressed on the root, and the coefficient of purity was 89. Other plots which were sown later will come to perfection late in May. It may be said, therefore, that sugar-beet suitable for the manufacture of sugar can be grown in this part of India—the Peshawar valley—certainly over the period March 15 to the end of May—that is, two and a half months. Whether this period can be extended either earlier in the year or later remains to be seen.

The life-history of the sugar-beet seems to differ here from that in Europe. Whilst in Europe the plant terminates its first vegetative period in the autumn with a yellowing of the leaf and cessation of growth, to be followed in the following year, if replanted, with a development of the flowering and fruiting stage, here in the Peshawar valley the second stage follows the first without any break, and some of the beets which were sown in September, 1913, have already flowered and "set" their seed. It remains to be seen whether by sowing in June and July the root will develop by December in the same way that it does in Europe, cease its vegetative growth temporarily, and then develop its fruiting stage when replanted in the following year.

Whilst the investigation into the possibilities of the sugar-beet crop have been in progress, the local sugar-cane crop has been examined. This is a thick cane, possessing a high proportion of juice, and yielding considerably more heavily per acre than most Indian canes; the general yield in the district is not less than 30 or 40 tons of stripped cane. Samples of canes brought from villages near the Government farm last December yielded from 70 to 75 per cent. of juice at the mill (a small bullock power iron mill is commonly used); the percentage of sugar in the juice was 11 to 12, and the coefficient of purity was about 80. In January the purity had risen to about 85, and the sucrose to 13 per cent. Thus the quality of the local cane is rather low from the manufacturing point of view, but the weight per acre and the proportion of juice extractable are high.

It is the practice in this Province to preserve cane from November, the beginning of the harvesting season, until the planting season in March, by placing the cane in "clamps," in manner somewhat similar to the "clamping" of root crops in Great Britain. Here the whole canes, with the leaf and the upper root, are laid on the ground parallel to one another and formed into a heap, which is then covered with earth. The cane remains perfectly sound in these heaps so far as the vitality of the buds is concerned. But it seemed of importance to ascertain whether the cane remains sound from the manufacturer's standpoint. The general experience in cane-growing countries is that sugar-cane depreciates very rapidly after it has been cut from the field; the sucrose decreasing and the glucose increasing. The temperature conditions in the Peshawar valley differ, however, from those of most cane-producing countries; the mean temperature in December is 51° F., in January 52° F., in February 53° F., and in March 63° F., and with such low temperatures it was an open question whether the usual depreciatory changes in the cane would occur.

Experiments made in December, 1913, and in January, 1914, have shown that harvested sugar-cane keeps perfectly well here in clamps. Thus four lots of different cane which were clamped in early December showed practically no depreciation when examined three weeks later.

Variety	Date	Juice per cent.	°Brix	Sucrose per cent.	Glucose per cent.	Coefficient of purity
Striped Mauritius	Nov. 24, 1913	65·8	14·3	10·9	2·2	76·1
	Dec. 15, 1913	67·3	14·1	10·6	1·9	75·2
Striped Mauritius	Nov. 26, 1913	72·0	15·1	12·1	1·6	80·3
	Dec. 17, 1913	69·1	14·7	11·3	1·8	77·3
Local Pounda	Nov. 28, 1913	76·7	14·9	12·0	1·9	80·9
	Dec. 19, 1913	71·7	15·1	12·1	1·9	80·1
Local Pounda	Dec. 2, 1913	74·7	15·4	12·2	2·3	79·5
	Dec. 21, 1913	67·8	15·1	12·1	2·1	80·0

Thus after being in clamps for three weeks there was found generally somewhat less juice (though this may have been partly due to the setting of the mill), but practically no change in the percentage of sugar or the coefficient of purity. Again in January another two lots of cane were clamped and were tested at intervals, with the following results:—

	Date	Juice per cent.	°Brix	Sucrose per cent.	Glucose per cent.	Coefficient of purity
Lot A.	Jan. 15.	76·9	15·6	13·1	1·7	84·0
	Feb. 16.	76·3	15·2	12·2	1·3	80·4
	Mar. 24.	72·5	15·4	12·8	2·0	83·2
	April 24.	70·7	14·9	12·6	1·5	84·9
Lot B.	Jan. 15.	76·7	15·9	13·6	1·5	85·8
	Feb. 16.	73·2	16·0	13·0	1·7	81·1
	Mar. 24.	72·4	15·1	12·1	2·0	80·2
	April 24.	71·6	14·8	12·2	1·7	82·1

So far, then, as these results can answer the question, there seems no doubt as to the possibility of being able to preserve sugar-cane perfectly well from the time when, owing to frosts, the crop must be harvested, to about the end of March.

All the experiments have hitherto been on a small scale, but they lead to the conclusion that a factory suitable for dealing with both cane and beet could be provided with material over a period of six months in the year, which is very considerably longer than the usual cane period in other parts of India. The suggestion for joint working is, moreover, free from the initial difficulty which would be met by a factory working only beet. If beet were the only crop, it would have to be established before a factory could start properly. Under conditions of joint working, however, the present crop of cane would supply a factory with material for certainly four months during the initial stages, and the beet supply could be added as the beet crop became established.

THE SUGAR INDUSTRY OF QUEENSLAND.

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The cane sugar industry in Queensland began, like many other industries, on a very small scale early in the settlement of the Colony. To-day Queensland practically produces almost all the sugar made in Australia, and it is estimated that last year the supply reached the sugar needs of the people of Australia.

In the 'forties and 'fifties of last century sugar-cane was grown in many private gardens in Queensland; a considerable amount was also grown in the Government Botanical Gardens, and it is stated there was a small sugar mill in existence on the Brisbane River in 1850, but it appears doubtful if any sugar was ever made. The first sugar from Queensland-grown cane, of which there is any official record, was made by Mr. John Buhot in 1862. In 1863 Captain the Hon. Louis Hope had 20 acres under cane on Ormiston Plantation, near Brisbane, and that gentleman is generally conceded to be the father of the Queensland industry. In 1863 the London Society of Arts offered a medal for the first ton of sugar made in the Colony. The first sugar-cane plants were most probably imported from Mauritius, but at this time the Acclimatization Society took active steps in bringing over a large number of varieties. Land was made available for some years by the Government on remarkably easy terms, and in 1865 over 1,800 acres were taken up for cane growing. By the end of 1867 there were about 2,000 acres under cultivation and six mills, which manufactured between them 168 tons of sugar. Up to this time the industry had been carried on entirely in southern Queensland, but it now began to spread to Bundaberg, Mackay, the Herbert, Johnstone River, and Cairns. It is in these places to-day that almost the entire output is manufactured, the extreme southern districts making very little. From this period the industry commenced to expand till 1875, when a disease termed "rust," combined with an excessive rainfall, ruined nearly all the cane, and a good many of the cane farmers with it. The financial institutions became alarmed and refused to render further aid. The variety most affected was the Bourbon cane, but it was noticed that small patches of Rappoe or Rose Bamboo were not touched. Those who survived the blow commenced the cultivation of this variety, and confidence was soon restored, though many plantations changed hands. During 1879 and 1880 a rush set in for Queensland sugar lands, and plenty of capital was made available. The production of sugar in tons from 1870 to 1880 is given as follows:—

Year		Tons	Year		Tons
1870	...	2,854	1876	...	8,214
1871	...	3,762	1877	...	13,784
1872	...	6,266	1878	...	13,525
1873	...	7,987	1879	...	18,982
1874	...	12,108	1880	...	15,681
1875	...	6,322			

During the next decade, 1881 to 1890, the production in tons varied from 16,660 to 68,924; 1891 to 1900, 51,219 to 163,734; and 1901 to 1910, 76,626 to 210,756; while last year (1913) it reached 241,496 tons. The cane manufactured into sugar for this record crop was 2,065,144 tons produced on 103,090 acres.

From 1863 to the advent of Federation in 1901, the sugar industry was almost entirely carried on by South Sea Islanders. This class of labour, while eminently serviceable and of the greatest use in opening up the country, was always distasteful to the majority of Australians, and when Federation took place steps were taken to make the industry entirely a "White" one. This was accomplished by passing a measure prohibiting Kanakas entering Australia after 1904, and providing for the deportation of those who had been engaged within a certain period. This only left some 2,000 Kanakas in Queensland, the majority of whom had resided for years in the State and had married. About the same time the Federal Excise Act came into operation, which provided for a protective duty of £6 per ton on all foreign sugar. An Excise duty was collected on sugar manufactured in Australia, and a rebate was given to that in which white labour was used. The final Act provided for an Excise of £4 on manufactured sugar, and a rebate or bounty of £3 per ton to the white grower. Growers employing black labour were thus penalised to this extent. This state of affairs continued practically till last year, 1913, when the percentage of aliens employed in the industry was almost negligible. The Commonwealth, therefore, rescinded the Excise and Bounty Acts, and maintained the protective tariff of £6 per ton on condition that the payment of the old bounty of £3 plus £1 hitherto retained by the Commonwealth for revenue purposes was ensured to the growers by the State Parliament. This has since been done, while steps have also been taken to secure the maintenance of the white labour ideal. The sugar industry of Queensland, as in most other countries, seems to be the favourite ground for politicians; from 1872 to 1913 no less than twenty-six Acts have been passed in relation thereto.

Sugar is grown in Queensland from 28° to 16° of latitude, the bulk being produced within the tropics. No difficulty is now experienced in securing white men to undertake the work in field and mills. During harvest time, June to December, hundreds of men from the southern States come to Queensland for the cane cutting. This work is usually done at contract rates, anything from 3s. 6d. to 6s. per ton being paid, and good cutters can average £5 per week. Adult labour employed in other field operations now receives £2 8s. per week without keep. Although conditions are somewhat trying in the north during the last two months of the year, yet the men are healthy, the death-rate is low, and sunstroke rare. The general standard of the health of school children is considered good, and epidemics are stated by medical men to be attended by a lower mortality than in the southern portion of Australia, and that with proper care the probability of children born in the north living to adult age was greater than in the southern portion of Australia, and, further, that the most prevalent cases of tropical complaints were preventible. The industry may now fairly be said to be on its feet, provided no further adverse legislative interference takes place. The average price paid to growers of cane in Queensland may be stated as 23s. per ton, and the value of the industry to the State last year may be summarized as under:—

Cane growers received 23s. per ton on 2,065,144 tons of cane	£2,374,915
Raw sugar produced 241,496 tons at £16 per ton	3,863,936
Refined sugar made from above, say 227,000 tons at £22 ...	4,994,000
Cane cutters paid 5s. per ton on 2,065,144 tons of cane ...	516,286
Field labour paid	500,000

There are now fifty-one sugar mills and two refineries in Queensland, and it is estimated that £406,936 was paid in 1912 to the 4,282 hands employed therein. The amount invested in the industry is estimated at between £7,000,000 and £8,000,000, made up as under:—

Machinery, premises, etc.	£2,462,266
Farms, etc.	5,0c0,000

The Government of Queensland have naturally always taken a warm interest in its sugar industry, and they have at different times advanced £500,000. This was used in the building of central mills of a co-operative character, thirteen of these being erected. Four of these are run directly by the Government. Of the remainder, four have paid their entire liabilities to the State and manage their own affairs, and the balance, while not clear, have paid their interest and redemptions to date.

Two fine up-to-date mills are to be erected in North Queensland by the State during the next three years, each to be capable of manufacturing upwards of 10,000 tons of sugar. Six of the fifty-one mills are owned by the Colonial Sugar Refinery Company, a wealthy corporation having vast interests in Australia and Fiji; the remaining mills are owned by private companies and financial institutions. The future of the sugar industry in Queensland can, therefore, be said to be a promising one, offering ample scope for emigrants.

The Government some thirteen years ago also formed a Bureau of Sugar Experiment Stations in order to assist the industry. This institution conducts soil investigation and classification, experiments in cultivation, rotation and manuring, and the introduction and testing of new varieties of cane. Many of the latter have been brought over from the adjacent island of Papua, or New Guinea, where there are stated to be immense numbers of sugar-cane varieties being grown in the gardens of the natives.

The best variety of cane grown in Queensland at the present moment is a New Guinea cane called Badila. It is an exceedingly rich cane with a small percentage of fibre. The following is an analysis of the Badila cane:—

°Brix total solids	Sucrose in juice per cent.	Glucose in juice per cent.	Sucrose in cane per cent.	Quotient of purity	Available sugar per cent.
22·6	21·4	0·21	18·6	95·0	17·85

A large number of varieties are grown in different parts of the State, and, in comparison with other sugar-producing countries, Queensland is well to the front in the growth of canes of good sugar content. In the north, 1 ton of sugar is made from 6 to 8 tons of cane according to the condition of the mill treating the cane. The central district takes usually from 8 to 9 tons, while in the southern districts, which are out of the tropics, from 9 to 12 tons are used in manufacture. Many of the mills, more particularly those belonging to the Colonial Sugar Refinery Company, are thoroughly up-to-date and under skilled technical management.

Cultivation is also steadily improving, and fertilizers are being used to a much greater extent than hitherto.

Cane soils vary considerably in type and colour, from rich red, volcanic, and deep sandy alluvial to shallow soils of a gravelly nature. The following analyses are the averages of each of three sugar districts in Queensland in the north, central, and southern districts:—

District	Lime per cent.	Potash per cent.	Phosphoric acid per cent.	Nitrogen per cent.
Cairns	0·292	0·310	0·141	0·122
Mackay	0·829	0·223	0·165	0·122
Bundaberg	0·636	0·144	0·404	0·220

The Cairns soils are both alluvial and volcanic, the Mackay soils all alluvial, and the Bundaberg soils all volcanic.

The rainfall on the coast in Queensland where cane is grown ranges from 130 in. at Innisfail to 40 in. at Bundaberg. Irrigation is only used in one district, viz., the Lower Burdekin, where the rainfall is small. Good results are obtained. Cane land varies in price from £5 to £60 per acre.

The sugar-cane plant in Queensland is subject to many pests and diseases. The most serious of these at the present time is the grub pest. The larvæ of Lepidiota and other scarabæid beetles attack the roots of the cane, causing the stool ultimately to fall and perish. Thousands of tons of cane, particularly in the north, have been destroyed, and a high price per lb. is now paid for the beetle. In Mackay over 15 tons of beetles have been captured within so short a time as two months and destroyed. The weevil borer (*Sphenopherus obscurus*) and the moth borer (*Diatræa saccharalis*) do a certain amount of damage, but have not so far called for urgent repressive measures. The gumming disease of the cane caused by *Bacillus vascularum*, Cobb, is at times a very serious trouble, both in the field and in the mill, but, so far as the writer's experience goes, gumming of the cane is not found to any extent north of Mackay, and appears most prevalent in cooler climates. Certain varieties of cane, particularly the older sorts, such as Rose Bamboo and Striped Singapore, are particularly liable to the disease, while in the best of the New Guinea canes no traces of it have been found, though the poorer kinds are far from immune.

Apart from its great economical importance, however, the sugar industry in Queensland possesses a phase of far higher significance. In 1911 a Royal Commission on the industry was appointed by the Federal Government. This body sat for upwards of twelve months, and collected a mine of evidence in all parts of Australia. Their report was finally handed in at the end of 1911. That report stated emphatically that the Queensland sugar industry was one of national importance, the maintenance of which vitally affects every citizen of the Commonwealth. By no other means at present visible can our vast Northern littoral be peopled and defended, and for this reason alone, apart from its enormous economic importance, it deserves the utmost encouragement and support that our Federal and State Legislatures can give it. The Commission have put this view in the strongest terms when they say: —

"The problem of the sugar industry to-day is not, save in subordinate respects, a problem of industry, of wealth, or of production; it is primarily and essentially a problem of settlement and defence. No nation can afford to regard lightly the development of its industries, the progress of its wealth, or the economic efficiency of its productive machinery. But, important as these things undoubtedly are, they rank, as regards the sugar industry, on an inferior plane. The Commonwealth to-day is brought face to face with one of the gravest problems that has ever taxed the ingenuity of statesmanship—that of the settlement of tropical and semi-tropical areas by a white population living under standard conditions of life. And intimately associated with this problem is the question of national defence.

"If the ideal of a White Australia is to become an enduring actuality some means must be discovered of establishing industries within the tropical regions. So long as these regions are unoccupied they are an invitation to invasion as well as a source of strategic weakness. Granted so much, it follows that the supreme justification for the protection of the sugar industry is the part that the industry has contributed, and will, we hope, continue to contribute to the problems of the settlement and defence of the Northern portion of the Australian continent. The recognition of the nature of this supreme justification is the first condition of a sound public policy in relation to the sugar industry. Relating to it all other issues are of minor importance."

LA PRODUCTION SUCRIERE A L'ILE DE CUBA.

Par RAFAEL MARTINEZ ORTEZ.

LA canne à sucre, introduite dans les Antilles par Cristophe Colomb des îles Canaries pendant son second voyage, y prit bientôt un grand développement. Elle trouva un terrain et des conditions atmosphériques extrêmement favorables. On peut assurer qu'elle ne les rencontre pas supérieures dans aucune autre région de notre planète.

Elle fut importée à Cuba par Diego Velazquez de Cuellar et ses compagnons, les premiers colonisateurs de l'île. Celle-ci a une superficie de 120,000 kilomètres carrés. Presque tous ses terrains sont adaptables à la culture de cette graminée; mais la production n'eut pas d'importance dans les premiers siècles qui suivirent la découverte et la conquête.

Elle était alors très peu peuplée et malgré sa merveilleuse fertilité elle fut presque exclusivement consacrée à l'élevage de troupeaux, à l'exploitation de ses bois précieux, principalement l'acajou, d'une renommée universelle, et à la culture du tabac. Cette plante fut trouvée la première fois par les Espagnols dans la Grande Antille où on l'employait de la même façon qu'on le fait aujourd'hui.

Pendant l'occupation de Cuba par les Anglais l'île fit de notables progrès dans sa production, par les dispositions de liberté commerciale adoptées, et ces progrès continuèrent après que l'Espagne eut repris sa domination. Elle maintint en vigueur quelques-unes de ces mesures.

Au commencement du XIX siècle la culture de la canne à sucre avait augmenté notablement. En 1850 Cuba exportait déjà 223,145 tonnes de sucre. Dix-huit ans plus tard, en 1868, au commencement de la première guerre pour l'indépendance, elle avait augmenté jusqu'à 749,000 tonnes sa production. Mais elle resta stationnaire pendant toute la durée de cette guerre. La plus grande partie des centres de production, spécialement Matanzas, Havane et Pinar-del-Rio, souffrirent peu pendant cette période. Seule la région orientale fut totalement dévastée. A ce moment commença le développement de la production européenne du sucre de betterave. Jusqu'à 1889 la production cubaine se maintient entre 500,000 et 700,000 tonnes. Elle monta à un peu plus d'un million par l'augmentation du prix qui suivit le traité Foster-Albacete de 1892 entre les gouvernements de l'Espagne et des Etats-Unis d'Amérique. Ce traité fut dénoncé le 1° août, 1894.

Quelques mois plus tard, en 1895, la seconde guerre pour l'indépendance éclata. Celle-ci détruisit totalement la richesse de l'île.

La production de sucre descendit énormément; elle n'atteignit pas 300,000 tonnes en 1900. Avec la paix elle augmenta de nouveau; atteignit le million en 1903, dépassa le million et demi en 1909, et arriva à deux millions et demi en 1913 et dans l'année courante; c'est à dire, plus d'une tonne par habitant, la population totale ne dépassant pas deux millions et un quart.

Le prix d'une tonne de canne à sucre peut être inférieur à douze francs avec utilité pour le cultivateur, dans ce prix tous les frais sont compris jusqu'à l'entrée dans les moulins. Les opérations les plus coûteuses sont la coupe et la mise des cannes sur les camions et le transport jusqu'à l'usine.

Ces travaux sont payés de 5 à 8 francs, quelquefois un peu plus selon les distances à parcourir et les conditions où se trouvent les cannes. Les frais industriels, l'envoi aux ports d'embarquement, les dégâts des machines, etc., varient beaucoup, mais ne dépassent jamais 60 francs la tonne de sucre. Dans les usines situées près de la mer ils sont notablement moins élevés, ce rendement peut se fixer entre 11 et 12 pour cent.

Si l'Europe consommait le sucre dans la même proportion que le fait l'Angleterre, ou même dans celle des Etats-Unis, qui est de beaucoup inférieure, cette partie du monde absorberait la totalité de la production mondiale, ou à peu près.

On sème toujours la canne à sucre par des tronçons. Cette pratique, continuée pendant des siècles, a déterminé une véritable et presque complète stérilité de la plante. Il est très difficile maintenant d'obtenir des graines fécondes en épis de la canne à sucre, mais Mr. E. Atkins, dans sa merveilleuse plantation "Soledad," près de Cienfuegos, soutient à ses frais une Station agronomique spéciale, où depuis quelques années déjà on travaille à la reproduction de la canne à sucre par ses graines. Dans l'Exposition agricole générale de Cuba de 1912 cette Station présenta un grand nombre de variétés de cannes obtenues par des graines. Les études continuent encore, et peuvent aboutir à des résultats très importants pour l'augmentation de la quantité de sucre dans les cannes. Toutes les personnes désirant des renseignements précis pourraient se diriger directement à la Station expérimentale de Mr. E. Atkins, ou bien à la Légation de Cuba à Paris.

Le sucre étant un produit alimentaire d'une très grande importance il serait très utile d'arriver à des solutions fiscales en tous les pays qui rendissent possible l'accroissement de la consommation et principalement qui empêchassent la substitution du sucre par des produits chimiques qui n'offrent pas ses excellentes qualités alimentaires.

SUGAR-CANE INSECTS AND THEIR CONTROL IN BRITISH GUIANA.

By G. E. Bodkin, B.A., Dip. Agric. (Cantab.), F.Z.S.. F.E.S.

Government Economic Biologist, British Guiana.

Insect pests of sugar-cane have been known in British Guiana for at least the last quarter of a century, but it is only during more recent years that they have received any serious attention or combined efforts been made for their control.

To-day the injury and financial losses caused by such insects is fully realized, and the control of insect pests on a sugar estate in British Guiana is now a recognized part of the routine.

Owing to the somewhat peculiar conditions of cropping which are closely connected with the marketing of the product, cane at various stages of growth is to be found throughout the year, there being no recognized regular harvest. This renders the control of pests a particularly difficult matter, for as one area is cut these insects simply migrate to another adjoining area in a younger stage of growth.

The most injurious pests are those known collectively as "borers," which consist of three species of lepidopterous larvæ, namely, *Castnia licus*, Fab., a member of the exotic family Castniiadæ, which is popularly called the giant moth borer, *Diatræa saccharalis*, a member of the Pyralidæ, and well known in most of the sugar-growing areas of the world, which is termed locally the small moth borer, and *D. canella*, Hamps., which is much like *D. saccharalis* in all its stages, though described by Hampson as a distinct species.

These three pests pass their larval and pupal periods within the cane itself, thus weakening it and causing a material deterioration in the juice. Their attacks are often followed by a complete destruction by Termites or wood ants, whose function in the insect world is to entirely demolish all decaying or diseased vegetable matter.

Giant Moth Borer.

The giant moth borer confines its attack more to the stool or rooting system of the cane. It is a comparatively recent pest, as it appears to have been unknown twenty years ago. Since its first appearance it has multiplied at an exceedingly rapid rate, and during 1912 296,214 moths were destroyed, and 672,104 caterpillars and chrysalides. During 1913, 597,503 moths were destroyed, and 1,374,878 caterpillars and chrysalides.

Like many of the injurious insects of this part of Tropical America, Castnia has invaded the cultivated areas from the forest region, the original habitat of its larva being either orchids or the roots of wild plantains. It will also breed in the roots of cultivated plantains and bananas. The larva attains a length of 2 to 2½ in. No known true parasites of this pest have ever been discovered. This is due to the concealed habit of the larva and chrysalis, which is often some considerable distance beneath the surface of the soil, and the eggs are deposited in the most haphazard manner by the female moth, never being laid in any particular spot, but dropped one or two at a time about the cane plants. This, of course, excludes the possibility of egg parasites and reduces their chances to a minimum. Birds are the most important enemies of Castnia, especially the so-called kiskadee (*Pitangus sulphuratus*) and the old witch (*Crotophaga ani*), both of which are particularly fond of the adult moth. On all sugar estates organized gangs, principally composed of native-born East Indian children (known as Creoles), are employed in the destruction of this pest. The gangs vary in size from thirty to as many as 100 individuals on some estates. These children have grown remarkably astute at this work, and many of them now earn comparatively large sums of money.

The most effective control method employed is to send a gang of these children through a field of canes that has recently been cut. They search the stools of cane for traces of the borer, and wherever frass or an open boring is observed in the stumps a long hooked wire is introduced therein, and after some manipulation the larva, if present, is impaled and dragged to the surface. If this is not successful, the stump is partially dug up and the larva or chrysalis thus secured. This method gives excellent results. The caterpillars and chrysalides are kept by each individual in an old tobacco tin, and at the end of the day the contents are carefully counted and checked. A halfpenny apiece is paid for the caterpillars or chrysalides when they are scarce, but the price fluctuates. Boys provided with nets are also employed to catch the adult moths. A higher price is paid for the moths, which only fly during certain parts of the day.

Small Moth Borer.

The small moth borer has been known in the cane fields for many years, and much has been written concerning its life-history and habits. This small insect has been receiving considerable attention recently in Louisiana, where it has become a serious pest. It is capable of completing its life-history in other plants than cane, such as several species of grasses and Indian corn.

It confines its attacks more to the cane itself, and more especially during the first three months of the plant's existence.

The eggs are deposited by the female moth on the young leaves as soon as they appear, and the resulting larva bores its way gradually down into the centre of the plant, thus destroying the growing point and causing the central shoot to wither and die.

Older canes, especially those with a hard epidermis, are not so frequently attacked owing to the difficulty of gaining an entrance into the cane.

This pest is principally destroyed by the method popularly known as cutting out.

Gangs of East Indian children are sent through the fields of young cane, and wherever a dead central shoot is observed it is cut off close to the ground, split open, and the contained larva or chrysalis secured and placed in a tin. Fourpence a hundred is generally paid for the grubs and chrysalides, though this price, of course, fluctuates according to the abundance of the pest. Three hundred are usually collected by one individual during the day. Cutting out cannot be employed after the canes are four months of age.

During 1913, 25,583,987 caterpillars and chrysalides were thus destroyed. The collection of the egg masses of this pest has recently been commenced on some estates. The eggs are light yellow in colour, oval in shape, and are deposited overlapping one another in the mass. Though somewhat difficult to discern at first, with practice it is possible to collect quite a fair number during the course of the day. A small gang of specially trained children are employed in the work, and are well paid.

Two species of egg parasite of the small moth borer are commonly met with, and one *Trichogramma minutum*, Riley, has a world-wide reputation, as it is known to parasitize the ova of many species of Lepidoptera in many parts of the world.

Several species of external Hymenopterous parasites occur, one Dipterous parasite, and a fungus parasite, a species of *Cordyceps*. The larva of an Elaterid beetle also preys on the early stages.

These parasites, especially the egg parasites, perform excellent work in the control of this pest, and lines of investigation have recently been commenced with a view to increasing, if possible, their utility.

Other Pests.

Other more important pests include the so-called weevil borer (*Metamasius hemipterus*), which at times damages the stools and rooting system of the cane.

The larvæ of two Noctuid moths, *Remigia repanda* and *Laphygma frugiperda* (known in the United States as the fall dung worm), feed on the leaf-blades of the cane, and at times occur in enormous numbers, stripping whole fields of their foliage, and leaving nothing but the hard midribs. These are destroyed by collecting the caterpillars in buckets containing paraffin and water. They become most numerous on the advent of rains after prolonged drought.

Two species of Termites occur frequently, and their characteristically constructed nests may be seen in all parts of the fields. They destroy all canes which have been previously weakened by borer attacks, the tunnel of the borer often serving as an entrance. They will at times attack a healthy cane, though this seldom occurs. These pests have received attention recently, and the weeding gangs on all estates have orders to remove every nest which they meet with. These are collected in sacks, taken out of the field, and burnt.

A species of mealy bug occurs at times in large numbers beneath the sheathing bases of the leaf. When large numbers are present they undoubtedly weaken the vitality of the cane. These insects are destroyed in damp weather by fungus. In dry weather they multiply rapidly and remain healthy.

Two species of Cercopidæ, known throughout the West Indies as frog-hoppers, occur at times in small numbers, and their damage is negligible. Owing to the clean weeding invariably indulged in, the numbers of these pests never become a menace to the industry as they have in Trinidad.

This paper cannot be terminated without some reference to the splendid control work carried on by most of the sugar estates through the instrumentality of their managers. Although the pests have by no means yet been controlled, combined efforts are being put forth to this end, involving considerable inconvenience and expense to each estate, which is accentuated by the poor prices obtainable for Demerara sugar during recent times. Efforts such as these on the part of the practical man are exceedingly encouraging, and serve as an example to agriculturists in other parts of the world, who at times are inclined to consider economic entomology more in the light of an interesting hobby than a serious practice which will very handsomely repay the necessary initial expenditure.

PALMS AS A COMMERCIAL SOURCE OF SUGAR.

By H. E. Annett, B.Sc.Lond., F.I.C., F.C.S.

Agricultural Chemist to the Government of Bengal.

It is not generally known that the world's produce of palm sugar approaches half a million tons. Most of this is produced in India, and a small proportion in the Philippine Islands, the Dutch East Indies, etc.[1]

H. D. Gibbs[2] has recently published a full account of the industry as carried on in the Philippine Islands, and he seems favourably impressed with the commercial possibilities of the Nipa palm (*Nipa fruticans*) for sugar production. I have recently taken up a study of the palm sugar industry as it exists in Bengal. The results obtained to date have been published as a Memoir of the Imperial Department of Agriculture in India.[3] Here it is intended mainly to outline the case for and against the production of sugar from palms, as compared with other sources of sugar.

Kinds of Sugar-producing Palms.

Large numbers of palms are known to produce sugar, but the following only, as far as I am aware, have been recommended for sugar production on a commercial scale.

Phœnix sylvestris, the wild date palm, is by far the commonest sugar producer among the palms in India.

Borassus flabelliformis, the fan, or common toddy palm, is used for sugar production in Madras and Burma.

Cocos nucifera, the coconut palm, is used fairly largely in Madras for the same purpose.

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1 *Journal Royal Society of Arts*, April 21, 1911.

2 *Philippine Journal of Science*, April, 1911, vol. vi, No. 2.

3 *Memoirs Imperial Department of Agriculture in India. Chemical Series*, vol. ii, No. 6.

Nipa fruticans has already been mentioned. This is a swamp palm growing almost up to its crown in water, in marshy places by the sea.

Caryota urens, the Indian sago palm, is used to a small extent in Madras, and on the Malabar Coast has been credited with enormous sugar yields.

Arenga saccharifera seems to be commonly used in the Dutch East Indies for sugar production.

Method of Sugar Production.

The sugary juice is obtained from the young inflorescence in the case of the above palms, with the exception of *Phœnix sylvestris*, whose stem is tapped just below the crown of leaves. Fuller details of the tapping process are given in my Memoir.

Amount and Nature of Sugars in the Juice.

With the exception of Gibbs's work on Nipa, and my own work on *Phœnix sylvestris*, very little reliable data as to the sugar content of the juices of various palms is on record. The Nipa contains 16 to 17 grams of cane sugar per 100 c.c. of juice, and *Phœnix sylvestris* only contains 10 to 12 grams of cane sugar per 100 c.c. of juice as a rule. If the juice of *Phœnix sylvestris* be obtained under sterile conditions, I have shown that the only sugar present is cane sugar.

As drawn by the natives, *Phœnix sylvestris* juice contains many yeasts and bacteria, and inversion rapidly takes place. It is interesting to note the Phœnix juice is distinctly alkaline to litmus, and Gibbs has observed the same fact in the case of the Nipa.

A few odd analyses I have made of Borassus juice would seem to indicate that the sugar content is about 14 to 16 grams of cane sugar per 100 c.c. of juice.

Yield of Sugar per Tree and per Acre.

Work carried on throughout the palm sugar season in Jessore District, Bengal, shows that the cultivator, by his crude methods, obtains an average of about 23 lb. of raw sugar per tree per season in the case of *Phœnix* *sylvestris*. At 350 trees per acre, a fair estimate, this would yield 3·6 tons of raw sugar per acre. From information I have been able to gather, the yield of sugar from Borassus would considerably surpass the yields from Phœnix, and Gibbs's figure for Nipa would seem to promise large acreage yields of sugar in the case of that plant.

It must be noted that the figures I have quoted for Phœnix are figures actually being obtained by a most wasteful process.

Advantages of Production of Sugar from Palms.

The following are the chief advantages which palms offer as a source of sugar supply.

(1) *The certainty of the yield from year to year.* One need have no fear of drought or flood. These phenomena are practically without effect on the yield.

(2) *Small annual cost of upkeep of plantation.*

(3) *No outlay is necessary for crushing machinery*, which is a large item in cane sugar factories.

(4) *The long season possible*, owing to the fact that different palms yield sugar at different seasons of the year, *e.g.*, Phœnix from November to beginning of March, and Borassus from March to August.

(5) *Easy Factory Treatment of Juice.*—The juice, when fresh, can be read direct in the polariscope. This gives a rough idea of its cleanliness. It would require much less defecation than cane or beet juice. Owing to the reaction of the juice, even liming would be unnecessary.

(6) *Yield per Acre.*—It would seem possible, by better cultivation and plant selection, to increase largely the yield per acre and thus obtain larger yields than from cane.

Disadvantages of Palms as a Commercial Source of Sugar.

(1) *Lack of Fuel.*—In the cane sugar industry the dried bagasse, obtained after extracting juice from the cane, supplies sufficient fuel for the factory's need. We have no such fuel in the case of palm trees.

(2) *Time of Establishment of Gardens.*—A period of six years elapses from time of seed planting until the trees can be tapped for sugar. During this time, however, crops of early rice and of pigeon pea can be grown on the land. Further, when once established the garden needs very little annual upkeep, and each tree, in the case of Phœnix at least, will bear for twenty-five years.

(3) *Difficulty of Juice Collection.*—At present this would seem to be one of the chief drawbacks, but it might be possible to develop a system of pipe lines from the gardens to the factory.

(4) *Concentration of Sugar in Juice.*—In the case of Phœnix, with only 10 to 12 grams of sugar per 100 c.c. of juice, the work of evaporation would be much more tedious than in the case of cane juice. Nipa, and perhaps other palms, would be better than Phœnix in this respect.

Conclusions and Suggestions.

(1) It would seem that much higher yields of sugar per acre could be obtained from palms than from sugarcane, and the advantage of palms, as a source of sugar, seem to outweigh the disadvantages.

(2) A small factory has been at work in the Jessore District on palm juice during the past cold weather, and has produced some very high quality white sugars from the juice. These sugars found a ready sale locally. In the process no special treatment of any kind was given. After a small amount of preliminary heating the juice was concentrated in a vacuum pan.

(3) It would seem to me that a factory dealing with palm juice would be best run in conjunction with a distillery, so that it would not be dependent on a fluctuating market for the sale of its molasses.

COCOA.

THE QUALITIES IN CACAO DESIRED BY MANUFACTURERS.

By N. P. Booth
and
A. W. Knapp,
of Messrs. Cadbury Bros., Ltd.

Having been approached by the Organizing Committee of the International Congress of Tropical Agriculture to discuss before an audience interested in cacao planting the qualities in cacao regarded as most desirable from the manufacturer's point of view, we take this opportunity of expressing our thanks for the occasion so afforded.

It will give us pleasure if by this short paper, and any discussion it may evoke, we can be of some help to the planting community.

We believe that there are many planters who would be glad to know exactly what qualities in cacao are considered desirable by manufacturers of cocoa and chocolate. Unfortunately, it is by no means possible to make a definite statement which is generally applicable, because the various manufacturers look for different qualities, and cacaos from certain districts are prized for special purposes. There is, further, some danger in describing a desirable appearance, for it is not the appearance that is wanted, but the qualities that are associated with it. In general, we believe that if the planter only allows ripe pods to be gathered, ferments for a reasonable period, cures with care, and keeps the beans dry, they will have the right appearance to satisfy the manufacturers, and he will be producing the best that the type of tree on his plantation will produce. In many places the individual who does better work than his fellow-planter does not directly reap his reward in higher prices. This is to be regretted. Indeed, we have been told by planters that it does not pay to take more than a certain amount of trouble in fermenting and curing their cacao, as they obtain the same price any way, but if all planters worked down to the minimum quality, the price obtained for beans from that district would fall, and all would suffer. At present the planter who produces above the average is a benefactor to his fellow-planters, and he who produces below the average quality lowers the price of the whole production of that district.

Any district which could establish and successfully maintain a standard which *prohibited* the presence of unfermented, diseased, germinated, or grubby beans, and which *fixed* a maximum percentage for rubbish and shrivelled beans, and could at the same time put on the market large consignments of such beans, suitably marked, would be sure of establishing a reputation in the London market, and as a result obtain high prices.

Unripe Cacao.—In gathering the pods the planter should take care that only the ripe ones are picked.[1] If the pods are gathered before they are ripe, a poor yield is obtained and the cacao is of low quality—the beans being small, flat, and tough, with a whitish break. And, further, the shell is very difficult to remove. Unripe beans do not undergo the normal fermentation. In an experiment on our own estate in Trinidad unripe pods were purposely picked. In fermenting, the temperature never rose above 95° F. (*i.e.*, 15° F. below the temperature of a heap of the same size of ripe beans), and the beans appeared gummy and slimy. With ripe cacao the average yield of dry cured cacao is about 36 per cent. of the wet cacao put in the sweat-box. With this unripe cacao the yield was only half that usually obtained.

Over-ripe Cacao.—It must naturally happen on estates which have insufficient labour that the pods are often left on the tree after they have become ripe. As an

[1] The planting of a single variety on a plantation, as Mr. W. H. Johnson has pointed out, would greatly facilitate this.

experiment, pods were allowed to stay on the tree six weeks after they were ripe. When placed in the sweat-box the beans rapidly started to ferment, and after twenty-four hours were at least 10° F. warmer than the normal. After this the temperature was normal. The beans produced were large and plump, but the shells were crisp and fragile. When roasted the product was inferior to ordinary cacao. The friability of the shell is also an objection to over-ripe cacao. The danger with over-ripe pods is that the beans may have commenced to germinate. One objectionable result of this is that when they are dried the germ frequently produces a hole in the shell, which opens a way for attack by mould and grubs.

Germinated Beans.—Beans which have germinated (whether by being left in the pods till very much over-ripe or scattered on the ground by squirrels that have attacked the pods) give on roasting a very inferior product, with a herbal odour and an astringent taste. The product is so unlike cocoa that the presence of even a small percentage of germinated beans exercises a marked deteriorating effect on the quality of any goods in which such cacao is used, hence we regard the presence of germinated beans as particularly objectionable.

Unfermented Cacao.—We understand that unfermented cacao finds purchasers, but fermented cacao always obtains a higher price (usually about 4s. per cwt. more than the unfermented). The reason for this is that unfermented beans produce a cocoa inferior in colour, odour, and flavour. Partially fermented beans suffer from the same defects. On some plantations one day's picking is put on the top of the previous day's picking, and uneven fermentation is the result. In some cacaos one finds "cobs" (two or more beans stuck together); their presence is regarded as an indication of careless preparation, and certainly such beans cannot be properly fermented. We think there is usually little danger of *over-fermentation*, but where this occurs the shell may get so loose that it becomes broken in carriage and handling.

In particular we would point out that cacao can be spoiled by lack of attention to conditions of cleanliness during fermentation, or by exposing to bad odours. On curing these defects may be hidden, only to be revealed again on roasting, when the objectionable "hammy" or other flavour is developed.

Fermentation: New Methods.—Whilst at present we are very well satisfied with the standard methods of fermentation practised in the tropics, we look forward in the future to interesting developments. But as yet we are not prepared to recommend any radical changes. For example, the very interesting method of removing the pulp recently put forward by M. Perrot, which consists of treatment with alkali, does not appear very promising from the commercial standpoint. It is clear that such methods would not decrease the cost of production in the country of origin, and the manufacturer would have the extra expense of treating such cacao before roasting. Further, considering that on the vast majority of plantations several botanical varieties of cacao grow up side by side and that these are never sorted according to their kind, there is very little prospect of a uniform product such as manufacturers desire—and M. Perrot promises.

Washing.—After fermenting it is usual in some countries to remove the pulp by washing. This process slightly reduces the weight and improves the appearance of the bean. It has the disadvantage, however, that it leaves the shell thin and breakable, and renders the cacao more liable to attack by grubs; it is also probable that when such cacao is placed along with other cargo having a strong smell, it more easily takes up such flavours than the unwashed cacao.

On the whole we recommend that (save in those countries where washing is considered essential to satisfactory sun-drying) the beans be not washed. The planter obtains a bigger yield, which fetches in England practically the same price per cwt.,[1] because the unwashed product is considered to have better keeping properties.

Drying.—It is essential that beans should be thoroughly

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[1] Dr. Fickendey, Cameroons. The loss amounted to 8 to 10 per cent. without adding to the price realized by the product.

dry before being bagged. Care must be taken not to over-heat the cacao or to break the shells. In some countries the climate necessitates *artificial drying*. But in places where the sun's heat can be used, it is always to be preferred, because there is a tendency with the use of artificial heat to speed up the drying process, and our opinion is that such rapidly dried beans are not so well cured as those dried slowly in the sun.

Cleaning.—From a manufacturer's point of view, the freer the beans are from dried placenta, flat beans, and rubbish, the better. Recently the planters on a certain West Indian island have been sending so large a percentage of shrivelled beans and waste to New York that there seemed some risk of the American market being closed against them. Happily, they have mended their ways, and are now delivering cacao satisfying contracts in which the waste must not exceed ½ per cent.

Claying.—Claying makes beans look pretty; it is said to materially assist in the drying, and it is generally held that the film of clay protects the beans from attacks of mould, and also strengthens the shell for handling. Personally, we question the last two advantages, and would point out that from the manufacturer's point of view claying increases the cost of production, and that the buyer pays for cacao and obtains clay. However, we do not think that objection would have been raised to claying if the process had not been abused in recent years. One abuse is using above 1 per cent. of clay.

A more serious abuse is the taking of black cacao from diseased pods, and claying this so as to give it the appearance of good estate cacao. This use of claying is sufficient to condemn the practice from the manufacturer's point of view, more particularly if merchants mix this diseased cacao of deceitful appearance with fine cacao.

Dancing and Polishing.—Where dancing is used, not as a method of breaking apart those beans which are stuck together, but simply as a method of applying clay and producing a polish, it has little to recommend it. Dancing improves the appearance of the beans and gives them a very pleasant gloss, but from a manufacturer's point of view we have no evidence that this process is of any advantage. We consider that the 2d. per cwt. spent on this is wasted.

There are mechanical *polishers* which give the beans a bright and uniform appearance. Such beans fetch a slightly higher price, but manufacturers will in future value beans more and more on their internal qualities alone.

Size.—Large beans are preferred because they have a lower percentage of shell than small beans, and cacao carefully graded to size is more appreciated because it affords greater facility for uniform roasting.

Flat Beans.—Manufacturers object to flat beans because:—

(1) Flat beans shell less easily. In the rounder bean the shells are more free.

(2) Flat beans have a greater percentage of shell.

(3) Flat beans do not roast so evenly.

(4) Flat beans are generally evidence of unripeness, insufficient fermentation, or careless drying. Good curing of ripe cacao produces a round bean, and, as is well known, Criollo give the roundest or boldest, and Calabacillo the flattest bean.

Grubby Beans.—Cacao sometimes arrives in England much eaten by grubs. The cacao moths should be kept away from the beans during drying as much as possible. They deposit their eggs on the beans, and the grubs which hatch out eat their way into the beans with broken shells. The trouble does not always end here, as the moths may migrate in the stores to other bags of cacao. Beans with the minimum of broken shells best withstand their attacks.

Aroma and Break.—The beans should have a clean, pleasant, faintly acid odour; the presence of the slightest foreign odour is objectionable.

Beans should break readily into small crisp nibs. Any show of hardness or cheesiness lowers their value.

Constancy of Quality.—Probably the most highly appreciated character is constancy or reliability of quality. Cacao which varies from bag to bag or from time to time will get little appreciation. Under ideal conditions standard qualities would be put on the market—Criollo, Forastero, and Calabacillo would be fermented separately, and the beans graded according to size. Such a procedure would only be practicable where the cacao from several plantations was taken to a central fermentary. At the present time we are far from this; indeed, instead of a careful grading of good qualities there is in practice a mixing of good and bad. We have good reason to believe that some merchants buy cacao which they know to be diseased or unfermented or mouldy, and deliberately mix it with good cacao. Such an action may not seriously affect the price of that particular lot, but it affects detrimentally the reputation of the cacao from that district, and the manufacturer comes to regard it as less desirable.

It is sometimes stated that cacao is valued largely according to its geographical origin, but we would point out that this value is the resultant of the value of the type of bean grown in that district and the amount of care given to the curing—thus a reputation is established for that district. It is also sometimes contended that the value of cacao depends almost entirely on its botanical variety. It is the old problem of heredity and environment. Criollo obtains a higher price than Forastero and Calabacillo because it is the rarest. But the planter's problem in most parts of the world is how to produce the best cacao from the mixed breed which his plantation produces. This is done by providing a suitable environment, *i.e.*, keeping the trees under healthy conditions and curing the cacao with the greatest care. In Ceylon, since rubber became of such great importance, less care has been taken in the cultivation of cacao, and a deterioration of breed has resulted.

It should be pointed out that the manufacturer does not make a final judgment of the bean in its raw state. It is only when it is roasted that he is able to determine its exact value for his purpose.

It is to be regretted that in some places cacao is still taken to the steamer in surf boats. Well-prepared cacao then becomes wet with sea water, and as a result may later be spoiled by mould. We would like to emphasize the necessity for piers and jetties to enable beans to be shipped in all weathers without getting wet.

THE GOLD COAST COCOA INDUSTRY.

By W. S. D. Tudhope.

Director of Agriculture, Gold Coast.

The Gold Coast commenced to export cocoa in 1891. The official figures for that year gave the quantity exported as 80 lb. in weight, valued at £4.

The export of the past year was 113,239,980 lb., valued at £2,489,218.

The growth of the industry can best be ascertained by a glance at the following table. The figures in every case are obtained from official sources:—

Year	Quantity	Value £	Value of increase in five years £
1891	80 lb.	4	—
1896	86,754 „	2,276	2,272
1901	2,195,571 „	42,837	40,561
1906	20,104,504 „	336,269	293,432
1911	88,987,324 „	1,613,468	1,277,199
1913	113,239,980 „	2,489,218	875,750*

* Increase in two years.

The Gold Coast is now the largest cocoa-producing country in the world, and the industry is exclusively a native one.

It was in 1911 that the Gold Coast first attained the distinction of being the largest cocoa-producing country, and it is evident from subsequent returns that she has not yet reached her maximum production, as the exports for the past year (1913) are almost one-third more than that of any previous year. Figures available for the first quarter of the current year also show an increased production of over £200,000 worth on the previous year's record for the same period.

For the purpose of this paper I propose to give a few facts concerning the present condition and affecting the future development of the industry; and for a more detailed history of development I would refer members of the Congress to an article contributed by me and published in the *Journal of the African Society* in 1909.

The Gold Coast has never been looked upon as a white man's country (I mean as a residential country), and this has, to a large extent, restricted the introduction of European capital in the development of agriculture under the system of European-owned plantations. All such ventures, too, in the past have left cocoa culture almost severely alone, so, contrary to the experience of most other countries, the cocoa industry of the Gold Coast owes nothing to the European planter.

The Gold Coast is typical of the West African tropical bush. The greater part of the country is covered by tall forest growth. The contour of the land is undulating, containing low ranges of hills, and probably there are fewer swamps than in any other West African Territory, and decidedly less than the preconceived ideas at home of the West African Coast. Some of the low-lying land adjoining rivers is, however, liable to flood during the rains.

Extensive belts of oil palms are met with, which owe their initial formation to past generations of the native inhabitants. Palm oil and palm kernel production was at one time an important native industry, but the tendency now is to neglect the palms for the more lucrative and less laborious cocoa crop; nevertheless, they still remain, and constitute a crop of considerable potential value to the colony.

The country is far from being densely populated, but the population seems to be increasing annually, due in large measure to an influx of native races from adjoining territory. These people come, in the first instance, as labourers or carriers, and many of them in time become cocoa farmers. The population of the country, within the cocoa-growing areas of the Gold Coast and Ashanti, at the last census, taken in 1911, approaches 1,000,000 of all ages spread over an area of approximately 45,000 square miles. The density of the population in the different Provinces is shown in the following statement:—

Province or locality	Population per square mile
Western Province	16·7
Central ,, ...	53·4
Eastern ,, ...	44·3
Ashanti	11·6

These figures, however, may be taken as a conservative estimate, as there are many difficulties in the way of an accurate census being obtained.

The cocoa-growing area extends from 15 to 20 miles from the sea coast to about 180 to 200 miles inland, across almost the entire breadth of the colony, with the exception of areas of dry savannah or open grass country found chiefly in the eastern extremity of the colony.

The area of the cocoa-growing belt is approximately 24,000 square miles; and when due allowance is made for rivers, swamps, wind belts, native food cultivation, and forest reservation, a conservative estimate of one-fourth this area, or 6,000 square miles, may be taken as the area available for cocoa culture.

The total production of 113,239,980 lb. in 1913 is, therefore, equivalent to an average yield of 18,873 lb. per square mile, or about 29 lb. per acre from this area. The present conditions of the country render it almost impossible to procure reliable statistics of the area under crop, and no attempt has yet been made by Government in this direction; but the foregoing estimate, based as it is, I must admit, on a somewhat haphazard principle, gives in figures a comparative estimate of the present production, and indicates the possible limitations of the industry.

All other conditions being favourable, it is clear that the industry is capable of very considerable extension, and an annual increase in production is sure to continue for some years to come. Indeed, I am convinced that production will be limited first by the capacity of the native farmers rather than by the extent of suitable land available.

The yields per acre obtained over a series of years at the Government Agricultural Stations prove that the soil and meteorological conditions are very favourable for this crop.

At the Agricultural Station, Aburi, an average yield of about 8 lb. of cured cocoa per tree has been obtained during the past five years (1909 to 1913) from trees now over twenty years old, and though we have few accurate returns to guide us, from observation I should say that these yields are equalled, if not exceeded, on some of the best cared-for native cocoa farms in the more fertile districts. I should here state that these figures cannot be taken as anything like average returns for the colony, as on many farms and in some districts owing to neglect the yields are very low indeed. The Aburi yields, however, have been carefully computed, and prove that high yields can be obtained. Indeed, I might go further and say that I question if better yields of cocoa can be obtained in any other country in the world.

The cocoa trees yield a fair crop in the Gold Coast in the third and fourth years after planting, and, as showing their fecundity, I may mention that young trees were seen bearing fruits in less than a year after planting on one of the Agricultural Stations recently opened by Government.

The soil does not appear particularly rich, although over certain areas it is deeper and better than in others. Generally speaking, however, it is lacking in organic matter. It is to its climate, more than its soil, that the Gold Coast owes its wealth in vegetation. The air is humid, and although the rainfall is not excessive—from 50 to 70 in. per annum in the cocoa-producing districts—it is fairly evenly distributed. The humidity is in large measure due to the wealth of forest growth and evergreen vegetation, and this is its primary feature as a cocoa-growing country. The rainfall is lower than in nearly every other cocoa-growing country, and a reduction of the humidity, it is feared, would have disastrous consequences to the cocoa industry. The natives of the country are not fully alive to the seriousness of the position, as the destruction of forest in making new clearings is being somewhat ruthlessly undertaken all over the country, and a Bill recently introduced by Government for the regulation and preservation of the forests is being rigorously opposed by the native owners of the land, who, I fear, are not consulting their own better judgment in this matter.

The system of cocoa cultivation evolved by the natives represents a minimum of labour and expense. The forest is only partly felled, all large trees being left standing. Seedlings are raised on nursery beds on low-lying moist land adjoining streams, and they are generally planted out along with native food crops, such as plantains (Musa) and coco yams (Colocasia). In this way they are generally fortunate in getting a good start, as these crops afford a delightful cooling shade very necessary for the young seedlings. The cultivation given to these crops, which consists of a periodical weeding with a cutlass or hoe, is also beneficial to the cocoa trees, and tides them over the first two or three years. The temporary shade crop is, however, frequently allowed to remain too long, and tall trees with small crowns are the result. This, however, is the form of cocoa plantation favoured by the natives, viz., trees with clean stems 8 ft. or more long, the branches forming a thick canopy overhead. The principal reason why this form of plantation is favoured is because it allows the free progress of carriers throughout the plantation in collecting the crop, and from this standpoint it has a good deal to commend it. On the other hand, the trees are generally planted very closely together, and a corresponding overlapping or matting of the roots in the soil must be taking place which will sooner or later decrease the yield of the trees.

It is when the plantation is coming into bearing for the first time that it receives its first thorough clean up.

The natives generally have not yet awakened to the fact that the trees require other than the most meagre attention. The result is that weeding is seldom practised except for an occasional brushing with cutlasses, usually just before the crop is ready to be gathered. Pruning consists of the mere lopping off of branches in any haphazard fashion. The harvesting of the crop and the preparation of the beans is done in the crudest manner possible, and the necessity for manuring the trees has not yet occurred to the majority, and, worse still, the appearance of diseases is not yet viewed with any apprehension, and seldom is any action taken to guard against their inroads.

All these matters, however, have been receiving the attention of Government, and considerable progress has been made in instructing the native farmers in more rational practice. Every year shows a marked improvement in the management of the farms and in the quality of the product.

It has not to be forgotten that cocoa is a crop which was quite unknown to the natives, and had never been seen growing elsewhere except by a very few whose duties as artisans had taken them to Fernando Po and St. Thomé. They have had everything to learn, therefore, for themselves, and the way many of them have taken advantage of every facility for instruction afforded and are endeavouring to improve their methods reflects considerable credit on themselves and augurs well for the industry as a whole.

The cultivation and preparation of cocoa calls for more care and attention than the Gold Coast native has been accustomed to with any crop he has hitherto grown. Indeed, the production of a high-grade quality cocoa partakes of the nature of a scientific achievement, and is not yet even thoroughly understood by many Europeans engaged in cocoa planting. The question of fermentation is imperfectly understood, and the best methods by which this may be achieved are still a matter of considerable discussion. No hard-and-fast rule can be laid down with regard to the period of fermentation required to produce thoroughly fermented beans, since a great deal depends on the state of the seeds when they are first put to ferment, the ripeness of the pods, the length of time that has elapsed since they have been collected, the state of the weather at the time, and the receptacle in which fermentation is brought about. However, in dealing with a native community we must advocate some definite period, and our experience on the Gold Coast has shown us that fermentation for a period of six days invariably gives the best results. A few days longer does not appear materially to affect the quality if the fermenting mass is frequently stirred or turned.

The variety of cocoa grown almost exclusively is the oval-shaped Forastero type, "Amelonado" variety, the beans of which require a longer fermentation than almost any other variety known, and because of this, and the fact that this variety is both hardy and prolific, I think it is peculiarly suited to the conditions prevailing on the Gold Coast, and I consider it a lucky coincidence that this should have been the variety first introduced. Other types or varieties are under experimental cultivation on the Government Agricultural Stations, but with the exception of one—a spontaneously produced hybrid—none of them seem to be so prolific or as profitable as the ordinary type. The new variety, which I have called "Cundeamor" because of its resemblance in outward appearance to a Ceylon type of that name, seems to be prolific and produces very much larger beans, which have been pronounced of superior quality. This variety is being largely sought after by the natives, and in time considerable areas should be planted with it.

On the Gold Coast, fermentation, although causing additional labour, is in many ways a convenience to the native. He prefers to go leisurely about his work, thus fermentation is often unintentionally allowed to suit his convenience.

The process of fermentation originally adopted was to spread plantain leaves on the ground in the plantation, heap the cocoa beans thereon, and cover up the mass with similar leaves. Many use large baskets in which the fresh beans are placed. Wooden, and in some cases concrete, chambers have been adopted latterly by not a few. The cocoa is left for about a week, and the common error is made not to turn the mass, which results in unequal fermentation.

The cocoa is dried on mats made of the mid-ribs of palm leaves placed on a platform usually a few feet above the ground. As the industry develops, however, a tendency to spread the cocoa on the hard sun-baked roadway becomes more apparent. This is a practice that has many objections.

Some of the larger farmers have latterly constructed concrete drying yards in imitation of those adopted by the merchants, thus showing a laudable desire to follow an example which appeals to them, often regardless of expense.

European and trained native officers attached to the Government Agricultural Department are constantly employed travelling throughout the cocoa-growing districts delivering lectures and making farm to farm visitations, advising the farmers at their farms on more up-to-date methods. Instructions are in the majority of cases accompanied by practical demonstrations. Pamphlets giving hints on the various phases of the subject written in simple language have been published in English and several of the vernacular languages and distributed throughout the country. Youths are being constantly trained on the Government Agricultural Stations, and every year a six weeks' course in agriculture is given to school teachers, who in turn impart information thus gained to the children at school. School gardens have also been established.

Through all these agencies there is no gainsaying the fact that much good has accrued.

An excellent scheme of local instruction was inaugurated by His Excellency Sir Hugh Clifford, K.C.M.G., last year, whereby representative men are selected by the Head Chiefs, and after undergoing a course of training in cocoa culture at an Agricultural Station they return to their homes, and act as Instructors or Advisers in the division of which they are members, receiving periodical supervision from Agricultural Officers. It is hoped that in time this scheme may be brought into operation all over the colony, and with a sufficiency of supervising and advising officers, I feel sure the expenditure will be amply repaid in results.

His Excellency will pardon me for saying that the staff at my disposal has hitherto been far short of the requirements of the colony. It is generally easier to prevent initial blunders in cocoa culture, than to correct them after they have got thoroughly inured in a system, and with a comparatively small staff that has not been possible. Native suspicion of the object of Government in assisting them with their crops has also retarded better results, but I am glad to say this is gradually being overcome.

A matter of grave importance, so far as the Gold Coast is concerned, is the presence in the colony of cocoa diseases and pests. Natives are difficult to move in such matters. They seem to view any such appearance as a dispensation of Providence, against which they are powerless, and they as often as not put forth no exertion to prevent or destroy them. Cocoa plantations have suffered considerable damage (for the most part in the young state) from both insect and fungoid attacks. In the majority of cases, however, these have been associated with lax methods of husbandry, and in others with unsuitable soil or climatic conditions, or both, and no real serious pest has yet been found in the colony which could not be successfully controlled with display of a little additional care and energy on the part of the native owner.

The Officers of the Agricultural Department are ever on the alert for any new disease, and no opportunity is lost of impressing the natives with the importance of doing everything possible to prevent the appearance or spread of any pest. As a precautionary measure, legislation has been passed prohibiting importation from any other country of cocoa seeds or seedlings. Knapsack sprayers and syringes have been introduced for the use of native farmers, and they are constantly being trained in their use. It must be admitted, however, that in a country like the Gold Coast we are faced with a serious problem in the event of a destructive epidemic breaking out.

The commercial aspect of the industry is one of no mean importance. There is no gainsaying the fact that development has been fostered to a very considerable extent by the large trading firms in the colony. Indeed, I might go further and say that the development already attained has only been possible through their agency. The natives prefer to dispose of their cocoa at or near their farms; the transport of the material to the port of shipment is, therefore, very largely in the hands of the mercantile firms who have penetrated the bush, and erected large stores or buying depots wherever and as soon as production warranted such a course. Money is frequently advanced by them on prospective crops, but this practice, I believe, is now less common, and is not encouraged. The system is liable to abuse, and is not conducive to the production of the best grade of cocoa.

Keen rivalry is displayed by the different firms in purchasing the cocoa, and we have little ground for thinking that the native is not receiving fair value for his crop as a whole. We have reason, however, for thinking that sufficient encouragement is not being offered to prepare only the best quality. It is admitted there are many obstacles to be overcome before a perfect system of purchasing can be instituted, and some progress in recent years is apparent. We are indebted to Messrs. Cadbury Bros., of Bournville, for a lead in this direction. They have several agents in the colony who purchase on their behalf only the best qualities at an enhanced price, and reject all that falls below the standard of their requirements.

A study of the European market, however, reveals the fact that the difference in the price of the best and worst qualities of Gold Coast cocoa does not offer sufficient inducement either to the producer or the middleman to improve their grades. The highest grade is not more than 3s. to 5s. per cwt. above the worst grade of common cocoa. Viewed from a commercial point of view, therefore, when the relative cost of grading, packing, etc., is taken into consideration, it seems simpler and less expensive to buy, mix, and sell (all but the very worst) at a uniform price. That is the position of the market at present, and I fear, unless the manufacturer comes to our assistance with the offer of a relatively better price for the best quality, the native will become discouraged, and the quality of Gold Coast cocoa will recede. Who can blame the native for losing heart when he can sell unfermented, indifferently prepared, cocoa at the same price as he obtains for good carefully prepared material?

The quality of Gold Coast cocoa has very much improved within the last few years, especially in the older producing districts, showing that more care is annually being taken in its preparation. It would be unfortunate, therefore, if the quality should be allowed to revert to the low grade originally exported, more especially, since with the world's ever-increasing production, it stands to reason that the worst qualities must sooner or later be neglected. The position at present, I must admit, is one of some perplexity. But I repeat again that if better quality cocoa is wanted from the Gold Coast more encouragement should be offered in a greater differentiation in price between the best and the worst qualities.

The present price is a fairly lucrative one for the native, and even although cocoa should yet reach a lower level, that would not in itself, I feel certain, greatly affect supplies from the Gold Coast, although it would certainly affect those remote districts where already a considerable proportion of the price is spent in costly transport to the port of shipment. With the advent of railways, however, this contingency would to some extent be averted.

So far as the world's production of cocoa is concerned, I believe the Gold Coast is in as favourable a position as any other country for maintaining its supplies in future.

One of the chief obstacles in the way of the agricultural development of the colony as a whole is the great lack of suitable and cheap transport. Oxen or pack animals do not live except in a few isolated districts where the tsetse fly is not prevalent. They, therefore, are not available. The construction of roads suitable for motor traction has only been completed in a few districts, and the total length of railway within the colony is little over 200 miles. Motor lorries, cask rolling and man carts are used wherever the state of the roads will allow. The bulk of the transport, however, has to be accomplished by men or women carriers in headloads.

During the height of the cocoa season the scene presented at the various railway stations, central collecting depots, or shipping ports is one of animated bustle.

Carriers are both expensive and scarce, and the cocoa is often detained for several months at the bush stations before it can be brought to the coast. The relative cost of transport is also often so high that the price payable to the actual cultivator is frequently less than half the value of the cocoa at the port of shipment. Needless to say, such conditions seriously affect the quality of the product and tend to discourage the native cultivator.

Indeed, I believe in some cases the natives have allowed the crop to rot on the trees rather than go to the trouble of collecting it. The farms thus situated are generally receiving less attention, thereby encouraging diseases.

To alleviate these conditions an extension of the railway system is necessary and is being pushed forward.

Much of the labour now employed on arduous transport work when set free for employment in other channels will have a greater potential value to the colony. Needed reforms in the buying and grading of cocoa can then be more easily introduced, and the cocoa industry generally placed in a more satisfactory condition.

It might be suggested by the casual observer that the cultivators could co-operate in the matter of providing for themselves light railways for the transport of their produce, but at the present stage of development of the native such a scheme is hardly within the bounds of practical politics.

The formation of local Cocoa Associations for mutual benefit is at present receiving attention, and when a proper understanding has been created something on a more comprehensive scale may be attempted, and the provision of light local trolly rails, in addition to roads as feeders of the central railway, is worthy of consideration.

The native farmers own their lands, which they have either inherited or bought from other tribes. The bulk of the land appears to have belonged originally to the several tribes, and was vested in the separate "stools" for the use of the tribe as a whole. But the extension of the cultivation of permanent crops would appear to have altered the condition of land tenure, and each family now appears to be possessed of its own lands.

The area of the cocoa farms planted by individual families is small. A rough estimate of the average annual production of a cocoa farm in the older cocoa-producing districts might put the quantity at about 2 tons. Individual owners possess farms yielding as much as 25 tons, but the great majority of the farms are small, and their production does not exceed the former figure.

The tendency, however, is to extend the areas, as profits or production are erroneously based on the number of trees planted without any regard to the state in which they may be able to maintain them, and there are grave fears that farms are being extended beyond the limits the farmers are capable of maintaining in a satisfactory condition. This is a serious phase of the question over which we have little control, and friendly counsel frequently falls on deaf ears. All sections of the community are now interested in cocoa. The Coast natives have penetrated the bush to prosecute the art of cocoa cultivation. The wealthy natives who have made money as brokers or as artisans, and even those who have been educated in a profession, have become imbued with the spirit of cocoa planting, and are nearly all directly or indirectly interested. Indeed, we might say that cocoa production has become a part of the very existence of the Gold Coast native.

Ashanti and the Western Province of the colony were somewhat slower in taking up the cultivation, but every year shows a larger production in those regions, which a few years hence should be very much greater. We may truly say of the Ashantis, who were formerly a war-like race, that they have "turned their swords into pruning hooks." Cocoa has indeed had a great civilizing influence.

In conclusion, I would add that while one cannot but view with feelings of anxiety certain phases of the industry, we are all proud of our achievement as the largest producer of one of the world's important staple products—an achievement accomplished under many adverse circumstances—and I see no reason why we should not in future considerably improve our position.

COCOA IN THE SOUTHERN PROVINCES AND COLONY OF NIGERIA.

By W. H. Johnson, F.L.S.

Director of Agriculture, Southern Provinces, Nigeria.

Until the amalgamation of the Nigerias at the beginning of 1914, the Southern Provinces and Colony of Nigeria were known as the Colony and Protectorate of Southern Nigeria. This territory is situated on the West Coast of Africa, some 5° north of the Equator, and comprises an area of approximately 80,000 square miles, or about two-thirds that of the United Kingdom.

Introduction of Cocoa.

So far as I have been able to ascertain, cocoa was first introduced some thirty-four years ago by means of seeds brought by David Henshaw, a native chief, from Fernando Po. The original trees raised from seeds are still growing vigorously and yielding well at a plantation near Calabar.

In 1887 the Lagos (Ebute Metta) Botanic Station was established, and from there the distribution of plants and seeds to the Lagos district commenced a few years later.

The cultivation and distribution of cocoa at the Calabar Botanic Station commenced in 1893. Three years later there were well-established cocoa plantations, owned by the African Association, at Eket, near Calabar, and some of these trees are still in existence. About the same time the Oil Rivers Company started plantations at New Calabar.

In 1899 the Royal Niger Company formed plantations at Onitsha and Abutshi, on the banks of the Niger. A few of the oldest trees at Onitsha still remain in what is now a Government Agricultural Experiment Station.

Progress of the Industry.

The first shipments of cocoa were made in 1891. In 1900 the exports had risen to 4,042 cwts., valued at £8,622. Since that date they have steadily increased, and last year they amounted to 72,428 cwts., valued at £157,480. The exports, year by year, during the last ten years were as follows:—

Year		Quantity cwts.		Value £
1904	...	10,602	...	18,873
1905	...	9,405	...	16,922
1906	...	14,464	...	27,054
1907	...	18,654	...	47,840
1908	...	27,327	...	50,587
1909	...	44,814	...	71,916
1910	...	58,636	...	101,150
1911	...	88,025	...	164,664
1912	...	67,801	...	130,542
1913	...	72,428	...	157,480

Considerable interest attaches to this development, in view of the enormous progress made in cocoa cultivation in the neighbouring colony of the Gold Coast. At first sight it is somewhat difficult to understand why this industry should have developed so much more rapidly in one colony than in the other, considering that the conditions in each as regards soil, climate, and people are so similar. In the Southern Provinces of Nigeria, however, more attention has been devoted to the cultivation of cotton and maize and to the exploitation of products of the oil palm. The result is that Nigeria's exports of cotton and maize are considerably in advance of those of the Gold Coast, while her exports of palm oil and kernels are far greater, and have increased more rapidly than those of the Gold Coast.

Cultivation.

The principal cocoa-growing districts are Ibadan, Abeokuta, and Agege, which are respectively situated 122, 60, and 12 miles distant by railway from Lagos. All the plantations are owned by natives; those which were established by Europeans have been abandoned for various reasons. Except on the comparatively small number of plantations managed by educated natives the cultural methods in vogue are extremely crude.

When clearing land for a plantation, the large trees and oil palms are rarely cut down, and stumps are not extracted. The felled trees and bush are fired as soon as they have dried sufficiently. The land is then planted up with such temporary crops as maize, cassava, and tania (coco). These serve to assist in keeping down weeds, and to provide shade for the young cocoa trees.

Seeds from the November crop are sown in nursery beds made in a sheltered situation, and, if possible, near a good water supply. As they are generally sown too thickly, and seedlings are not thinned out, the latter become crowded together and develop into weak, straggly plants. A very large number, therefore, succumb when they are transplanted to the open field.

Transplanting usually takes place during the early rains in April and May, by which time the plants are about a foot high, but lining is not attempted. The plants are put in far too closely together, often as close as 4 or 5 ft. apart. The excuse for this procedure is that so many failures occur. On the other hand, where all the plants in a particular area survive thinning out is not practised. The plantations, therefore, present a most irregular appearance. In some areas the trees are suffering from undue exposure, while in others growth and fruit production are interfered with through overcrowding.

Shade trees and wind breaks are not planted, nor is mulch applied, so that the trees often suffer severely during the dry season. Especially was this the case during the last two years, when an unusually protracted dry season obtained, and numerous trees, both young and old, succumbed.

Little is done in the way of cultivation besides weeding, which is generally carried out at far too lengthy intervals. Pruning is not understood; what is attempted in this direction is restricted to the removal, by means of a cutlass, of dead branches and gormandizing suckers which develop from the main stem. Under these conditions it is not surprising that diseases are rife, crops are small and of poor quality, and the life of the tree is not great.

Diseases and Pests.

So far as it is possible to judge at present, Nigerian cocoa growers are not troubled with more fungoid and insect diseases than those of other countries. It is probable that many of the diseases which exist could be kept in check or even eradicated by the adoption of better cultural and sanitary methods.

Fungoid Diseases.—The brown-rot disease of fruits, *Thyridaria tarda*, Bancroft, in its conidial form *Diplodia cacaoicola*, Henn., is ubiquitous, but does not do so much damage as one would expect, considering that no combative measures are employed. The non-employment of shade trees is undoubtedly an important factor in checking this pest, though, of course, this procedure is not conducive to the general health and prolificacy of the trees.

An anthracnose disease of fruits, due to a species of *Colletotrichum*, is also frequently met with.

A stem disease, caused by a fungus new to science, determined at Kew as *Melanconium theobromæ*, probably an imperfect stage of a *Trichosphæria*, is also fairly common. But the etiology of this disease has not yet been fully worked out.

Thread blight, which is common in low-lying districts, is considered to be identical with the one found in Java.

The pink disease, *Corticium salmonicolor*, B. and Br., has also been found in one district.

The most serious root-disease is *Hymenochæte noxia*, Berk., and this occurs in every district where cocoa is cultivated. There appears to be little doubt that this disease can be kept in check by isolating infected areas with trenches and applying liberal dressings of lime.

Polyporus lignosus, Kl., formerly believed to be *Fomes semitostus*, Berk., has also been observed attacking the roots of cocoa trees.

Insect Pests.—The most troublesome insect pest of cocoa is the Melolonthid beetle, *Adoretus hirtellus*, Lap. This insect attacks the leaves of young plants; the portions of the leaf between the larger veins are eaten away, producing a characteristic lace-like effect. The beetle works by night, and hides itself by day, usually in the soil around the roots of the plant. Dusting the leaves with a mixture of Paris green and lime checked the attack, but as it scorched the leaves, spraying with chromate of lead solution was substituted and with good results.

Black aphis attack young leaves, but as they in turn are preyed upon by hover and lacewing flies no great damage is done.

The larvæ of two moths, *Eulophonotus myrmeleon*, Feld., and an Ægeriid, as yet unidentified, bore into medium-sized branches and destroy them.

Fruits are commonly attacked by two scale insects, *Dactylopius longispinus*, Targ. Tozz., and *Stictococcus svostedti*, Newst. Fortunately, the first is held in check by the larvæ of a butterfly, *Spalgis lemolea*, H. H. Druce, and the second by the larvæ of a moth, *Eublemma ochrochroa*, Hamps., and the Tortricid, *Tortrix callopista*, Durrant.

The fruit fly, *Ceratitis nigra*, has also been recently observed in cocoa plantations, and probably oviposits in the fruits.

The only two Lepidopterous larvæ of any importance which attack cocoa are the "woolly bear" caterpillar of the Lymantrid moth, *Diacrisia maculosa*, and a species of basket worm, the caterpillar of the Psychid moth, *Metisa sierricola*, White.

Preparation.

Although in many districts no attempt is made to ferment the seeds, this process is much more generally adopted than hitherto, but it is not carried out for a sufficiently long period. Amelonado is the variety usually grown, and its seeds require to be fermented for six or seven days, but the native rarely allows this process to extend for more than three days. It is a common practice to collect half-ripened fruits. To extract the seeds, the fruits are beaten on the ground until the shell is sufficiently fractured to permit of its being readily opened. The seeds are placed in heaps on mats or banana leaves spread upon the ground, or upon wooden platforms raised about 3 ft. from the ground. These heaps are covered up with banana leaves, matting, or some similar material. Here they are left for about three days. As the heaps are rarely turned, fermentation is not regular throughout the mass. The process of washing the seeds after fermentation is losing favour.

Curing is carried out by spreading the fermented seeds thinly in the sun on mats placed upon the ground or upon raised wooden platforms. This process also is too restricted.

From the preceding remarks it will be apparent that the product is frequently offered for sale in a half-dried condition, and contains many shrivelled, immature seeds, as well as seeds which have been subjected to different degrees of fermentation.

In outlying districts the bulk of the crop is purchased by native middlemen, who, on behalf of their European employers, pay a uniform price for all grades of cocoa offered for sale. As there appears to be a constant and large demand for low-grade cocoa, at prices remunerative to the grower, there is little incentive to him to raise the standard of his product.

As already mentioned, the variety grown is that known as Amelonado, and its seeds, however well grown and prepared. are inferior in quality to those of Criollo and other varieties which produce seeds with light-coloured cotyledons that are less stringent in flavour.

That cocoa superior to that usually exported from Nigeria can be produced by more careful cultivation and preparation is shown by the fact that, on the better managed plantations in the Agege district, the crops realize prices equal to those obtained for the best Gold Coast cocoa.

Cocoa from one of these plantations, which was prepared by the Department of Agriculture, has been valued at as high as 61s. per cwt., when ordinary West African cocoa was only fetching from 48s. to 56s. per cwt. The cocoa in question was fermented for six days and then sun dried.

Artificial Drying Experiments.

As regards climatic conditions for drying his crop, the cocoa farmer in Nigeria is particularly well favoured. The principal cocoa harvest is coincident with the dry season, November-December, when very little rain falls. During the rainy season a great deal of difficulty is often experienced in getting the crop dried without mould appearing. The Department of Agriculture has therefore considered the question of introducing some form of artificial drier. As the bulk of the crop is produced by quite small planters, who have not a large amount of capital at their disposal, and have little or no experience of machinery, it is obvious that a cocoa-drying machine, to be effective, must be inexpensive, easy to manipulate, and be "fool-proof." The Hamel Smith rotary drier appeared to satisfy these requirements, and the manufacturers, Messrs. Bridge and Company, very kindly provided one for experimental purposes. This was tested at the Government Experimental Station, Agege, last year. This machine comprises a revolving iron frame, to which are attached six perforated aluminium sheets, receiving cylinders enclosed in a metal chamber. Beneath the metal chamber is a furnace which supplies the necessary heat. Connected with the furnace is a chimney of sheet iron. The axle of the iron frame is fitted with a cog-wheel, which is connected by a chain with the cogs on a driving wheel. When the latter is turned, the metal frame, with the cylinders attached, revolves. The moisture driven off the material under treatment is drawn out of the chamber by means of a fan placed at the top of the chamber, which is also operated by the driving wheel. The motive power is supplied by hand, and one man is capable of manipulating it. Practically any kind of fuel can be used in the furnace. The cylinders are 18 in. long by 12 in. in diameter. They are made in two portions, which open on hinges. Inside the cylinders three sloping shelves are fitted, which, when the machine is in operation, check the fall of the seeds, and thus cause them to drop gently from shelf to shelf, and permit the heated air to circulate freely amongst them.

Two labourers are required to attend to the drier while it is in operation, one to turn the driving wheel and the other to obtain fuel (firewood) to feed the furnace, and to fill and empty the cylinders. The machine is quite simple of manipulation, and after a very little practice it was possible to obtain a fairly constant temperature of 100° C. It is not considered advisable to subject cocoa to a higher temperature than this during the curing process.

When the cocoa was transferred direct from the fermenting boxes to the drier, it was necessary for it to remain there for fifteen hours before it was properly dried; but by spreading the freshly fermented cocoa on wooden trays to dry for half a day, before placing it in the drier, this period was reduced by six hours.

To test the period required for artificial and sun drying respectively, freshly fermented cocoa was placed at the same time in the drier and on wooden platforms. It was found that it took fifteen hours and six days completely to dry the cocoa in the drier and in the sun respectively. It should be mentioned that the seeds in each case were fermented for six days prior to being dried, and they were not washed.

The artificially dried cocoa has a stronger flavour than that which is dried in the sun. It also has a greyish bloom on the exterior, which does not improve its appearance. This is attributed to a salt of aluminium, apparently produced by the action of acid in the pulp surrounding the freshly fermented seeds on the metal cylinder. The surface of the seeds beneath the bloom is better polished than in the case of the sun-dried product; this is caused by the rotary movement to which the seeds are subjected in the drier.

The cost of drying 100 lb. of freshly fermented cocoa in the drier was 2s. 6d., *i.e.*, two labourers for fifteen hours at 1d. per hour each. Cocoa taken direct from the fermenting boxes, and spread in the sun on wooden platforms, was completely dried in six days. By the latter method one labourer is capable of looking after six times as much cocoa as it is possible to place at one time in the drier. As a labourer's pay is 9d. per day, it follows that 100 lb. of wet cocoa can be dried in the sun at a cost of 9d. only. Cocoa loses approximately 50 per cent. of its weight in the drying process. The cost of drying cocoa in the machine and in the sun is therefore $\frac{3}{5}$d. and $\frac{1}{5}$d. per lb. respectively.

In these calculations the cost of wood fuel is not taken into consideration, for there is an abundance of timber in the neighbourhood of the Experiment Station, and one of the labourers attending the machine is able to keep the furnace supplied.

It is necessary to emphasize the fact that it is not desired to obtain a machine for curing cocoa during fine weather, such as that which obtained when the machine was tested, but for use in wet weather, when it is next to impossible to dry cocoa properly without the aid of artificial heat.

Four samples of the cocoa prepared during these experiments, as well as a sample of good, average quality cocoa produced on a native farm in the same district, were sent to the Imperial Institute to be examined and valued. At the time the samples in question were valued, West African cocoa was quoted in Liverpool at 51s. 6d. to 55s. 3d. per cwt.

Sample No. 1, which was transferred direct from the fermenting boxes to the drying machine and dried for fifteen hours, was valued at 57s. per cwt.

Sample No. 2, which was first dried in the sun for two hours and then machine dried for fourteen hours, was valued at 54s. 6d. to 55s. 6d. per cwt.

Sample No. 3, which was sun dried for three hours, then machine dried for nine hours, was valued at 61s. per cwt.

Sample No. 4, which was sun dried only, was valued at 60s. per cwt.

Sample No. 5, which was prepared on a native farm, was valued at 56s. per cwt.

The Imperial Institute report on these samples states that samples Nos. 1 and 2 appeared to have suffered from over-drying, and this is probably the reason for their being given a lower valuation than No. 3. It is interesting to note that Nos. 3 and 4 were valued at prices similar to those obtaining for St. Thomé cocoa, while the other three were valued at prices equal to those of the best grades of British West African cocoa.

Unfermented, Artificially Dried Cocoa.

As it appeared to me that cocoa could be satisfactorily prepared in this machine without first subjecting it to the somewhat lengthy fermentation process, experiments were conducted with this end in view.

In the first experiment seeds were taken from the fruits and placed in the machine at 6 a.m., and within twelve hours the temperature was gradually raised to 140° F. On the following day, and commencing at 6 a.m., the temperature was gradually raised in three hours to 212° F., and this temperature was maintained until the seeds were properly dried.

In the second experiment seeds were again placed in the drier at 6 a.m., but the temperature was gradually raised in six hours to 140° F., and in the next six hours to 212° F. On the following day the latter temperature was maintained until the seeds were properly dried.

Samples of these cocoas were also sent to the Imperial Institute. No. 1 was valued at 54s. 6d. to 55s. 6d. per cwt., and No. 2 at 54s. to 55s. per cwt. at a time when West African cocoa was quoted at 51s. 6d. to 55s. 3d. per cwt.

It will thus be seen that, although the unfermented samples were valued at comparatively high prices, these were 6s. per cwt., or 10 per cent., lower than those given to the best fermented sample.

Anticipated Development of the Industry.

A great deal of new land has been planted with cocoa within the last three or four years, and for this the Department of Agriculture has supplied about 90,000 plants and 164,000 seeds. This Department is also establishing small model plots of cocoa in the various districts suitable for cocoa cultivation. The object of these plots is to teach the planters how to plant and care for their trees, and when they come into bearing demonstrations as to the preparation of the crop will be given. In conjunction with these plots nurseries are being formed to raise plants for distribution. European Agricultural Officers and Native Agricultural Instructors visit the principal cocoa-growing districts to give instruction in the cultivation and preparation of cocoa.

When the newly planted areas come into bearing, and as planters become better acquainted with the proper way to plant and take care of their trees, it is anticipated that a very considerable increase in the exports of cocoa will be manifest.

NOTES ON CACAO CULTIVATION EXPERIMENTS.

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Trinidad has long been renowned for the quality of its cacao, and it has attained this position through the suitability of its soil and climate for the growth of cacao and through the skill and care employed in the preparation of the bean for the market. Although its area is less than 2,000 square miles, until 1910 it headed the list of British possessions for the quantity of cacao exported. It is the principal industry of the Colony, and in recent years experiments on a large scale have been started with the object of increasing the production by improvements in the methods of cultivation. This paper gives a few of the results obtained in the preliminary stages of the experiments, and it is hoped that they may be of some interest to those engaged in cacao cultivation. It also includes a reference to the various schemes for promoting agricultural education that have been introduced since 1900. No reference is made to the experiments in the removal of shade, the removal of suckers, or in wider planting, in grafting and budding, and in seed selection, as some years must elapse before definite results can be obtained. Only a passing reference is made to the manurial experiments for the same reason. The Government fortunately owns an estate on which experiments on a large scale can be made, and the greater part of the experiments are carried out there. In several privately owned estates in different districts small-scale experiments are being made under the supervision of officers of the Department of Agriculture. The estates record the results of these experiments. Altogether over 90 acres of cacao are included in the experiments.

The Natural Yield of Individual Cacao Trees.

Planters have for a long time been aware that some cacao trees bear more heavily than others, but in Trinidad I do not think that they had fully realized the extent to which the yield varied until the Department of Agriculture began its investigations in this direction a few years ago.

In these official records it is shown that the variation is very considerable, and that while some trees yield less that 1 lb. of dry cacao, others yield as much as 20 lb. or 25 lb. or more in a single crop year. It appears also from the records given in Table A (p. 208) that, as a rule, a heavy-bearing tree in one year bears heavily in the following year, and, on the other hand, that some trees give small yields in two successive years. If the records of future years are similar, the question of retaining in cultivation trees that give a low and unprofitable yield will have to be carefully considered.

The table shows the yield for two consecutive years, under ordinary estate cultivation, of 100 adjacent healthy trees in a fairy good field, giving in a year of normal rainfall a yield of 16 bags (of 165 lb. each) per 1,000 trees. The proportion of trees giving a low yield in this lot of 100 is not large. In other fields the proportion is somewhat larger, and in neglected cultivations it may be expected to be very much larger. In one very extraordinary case, reported in the *Bulletin* of the Department for October, 1913, a field of approximately 2,000 trees, remarkable for the almost entire absence of the ordinary "cushions," yielded annually, according to the manager's statement, only about 25 lb. of dry cacao. There can be no doubt that the yield of cacao trees, even when in a healthy condition and grown on a fairly good soil, varies very considerably. This may be due to a want of care in former years in the selection of the seed.

In Table B (p. 209) the percentage of trees giving not more than 2 lb. of cacao annually per tree is shown. These trees are in experimental plots now receiving manurial treatment. The percentage is high, but allowance must be made for the age (12 years) of these trees.

From Table C (p. 209) it will be seen that 58 per cent. of the trees have given less than 2 lb. of dry cacao per tree per annum. These trees are over 50 years old, and the cacao from this estate fetches a fancy price in the market.

It will also be seen from Table A that some trees give a yield of 267 to 290 pods per tree. This is equivalent to 133 and 145 bags per 1,000 trees respectively, which is a very high yield. An appreciable proportion of trees gave over 100 pods per tree, which is equivalent to over 50 bags per 1,000 trees; and there is reason to hope that with a careful selection of seed a minimum yield of 100 pods per tree is not an impossible ambition. Trinidad planters are impressed by these results and with the advantages of careful seed selection, and many of them now obtain seeds from these heavy-bearing trees on the Government estate, and all plants sold by the Department are raised from the seeds of these trees.

In Trinidad, 20 bags per 1,000 trees is a good yield under present conditions.

Owing to this great variation in the yield of individual cacao trees, it will be seen that it is not possible to make comparative experiments in the way usually adopted for other kinds of agricultural crops by taking as a basis for comparison equal areas or an equal number of trees. One acre of sugar-cane, or one stool of canes, is approximately equal in yield to another acre or stool if the variety of cane under comparison is the same; but our investigations have shown clearly that one cacao tree may equal in productive value as many as 12 or 14 cacao trees of the same variety grown under similar conditions.

Tables B and D (p. 210) clearly show the great variations in yield that occur in several adjacent plots in the same field, and it also indicates that, however large the number of trees in a plot may be, the natural yield from any plot may differ considerably from that of another plot of equal area. The same plots and the same trees do not differ from year to year to anything approaching the same amount.

Owing to these marked variations, the best course to be followed is to select carefully the required number of plots, and ascertain beforehand the natural yield of each plot for three or more years. This is being done in Trinidad, and Table F (p. 211) affords further proof of the great variations in the natural yield obtained from adjacent and carefully selected plots on different estates in various parts of the Colony. The yields from these plots are ascertained by the managers of the estates, who co-operate with the Department in carrying out these experiments.

Similar results have been obtained from plots on the estate owned by the Government, as shown in Table D. Here in Plot 9 the yield is nearly three times that in Plot 1.

The ten plots in this field are adjacent to each other, the total area does not exceed two acres, the trees are of the same age, the soil is to all appearances the same in each, and an analysis of the soil in five of the plots has shown that the chemical composition is practically the same in all. The results of the analysis are given in Table E (p. 210), and in this will be noticed a somewhat larger percentage of pebbles and sand in some plots, but the difference is insignificant in a soil of this character. The only conclusion that can be drawn from these tables is that the different yields from these plots cannot be due to any difference in the chemical composition of the soil.

Table G (p. 211) gives the yield from control plots on estates for two consecutive years, 1911-12 being a year of great drought, during which a large number of trees—and especially young trees—died from insufficient rainfall, and a still larger number suffered considerably, and 1912-13, a year of nearly normal rainfall, during which some of the trees injured by the previous year's drought, had not completely recovered. The effect of the drought on the young trees is strikingly shown in the California district. But even under such unequal conditions of rainfall the greatest increase in yield has not exceeded 35 per cent., and in other cases the increase or loss in yield has been small in comparison with the difference in yield from different plots.

The three control plots in Field 1 at River Estate have shown the following increases in 1912-13 as compared with 1910-11:—

A	increased	10	per cent.
G	,,	31	,,
U	,,	11	,,

In order, therefore, to carry out experiments in cacao cultivation, the natural yield of the plot appears to possess many advantages as a basis for a working standard of comparison. This yield will vary to some extent from year to year owing to variations in the amount of rainfall, to the increasing age of the trees, and to other causes. But this variation is considerably less than that obtained from adjacent plots of the same area.

On all well organized estates the owners keep a record of the annual yield from the different fields, and make field comparisons from year to year. A whole field is usually too large an area for experiments, but there is this advantage that the yield is already on record. At an early stage in the experiments at River Estate a whole field was placed under experiment. The trees were 30 years old and healthy in appearance, the soil was poor, and the yield was abnormally low. The yield before and after the experiments were made was as follows:—

Year		Rainfall Inches		Yield Bags	
1910	...	74·86	...	5·58	(natural yield)
1911	...	62·04	...	10·65	(under manurial experiments)
1912	...	62·03	...	12·18	
1913	...	65·77	...	9·31	

The normal rainfall in the district is about 80 in.

One section in this field was kept as a control, and has shown a rapidly diminishing yield, part of which is no doubt due to insufficient rainfall. But it will be noticed that a diminution in the rainfall has not affected the yield in the manured plots to the same extent, and not at all in the plot to which pen manure had been applied. This beneficial influence of pen manure and mulch has been shown in the experiments made in other parts of the Colony. The yield from each plot in this field is shown in Table H (p. 212).

Attention may here be drawn to the marked increase in yield obtained from pen manure and from mulch alone, or supplemented by small additions of mineral manures. Our tropical soils are deficient in organic matter or humus-forming materials, and this is probably due to the frequent surface washings to which they are subjected by heavy torrential rains. Pen manure and mulching material are, unfortunately, by no means abundant, and are, therefore, expensive.

Recording Results.

In Trinidad yields are usually recorded in bags, of 165 lb. each, per 1,000 trees. This probably arose from the Spanish carree of land, an area of $3\frac{1}{5}$ acres, on which ordinarily 1,000 trees were planted. The yield per acre would now be a more satisfactory method in an English colony, particularly when comparisons of the profits derivable from the cultivation of different kinds of tropical products are required.

But in carrying out our experiments the old method of reckoning had to be kept in mind, and our present method of giving the yield in "pods per tree" provides an easy comparison with the old method. If the number of "pods per tree" is halved we get the yield "in bags per 1,000 trees," if we assume that twelve pods are equivalent to 1 lb. of dry cacao. The number of pods equivalent to 1 lb. of dry cacao varies to some extent on different estates, and especially during dry years, but twelve may be taken as an average and convenient number for ascertaining for experimental purposes the approximate *weight* of dry cacao. The counting of the pods does not entail much extra cost. The relation between pods and weight should be checked at intervals. The results of such a check are shown in Table I (p. 212), which gives the figures obtained in different districts during a year of low rainfall.

In Table J (p. 213) the actual yields for five years on the Government estate are given. It is a young estate and contains trees of varying ages up to 30 years, and in one field up to 80 years. The table shows the yield from these trees of different ages, and before and during a period of low rainfall; but the returns are made up to March 31 to correspond with the official financial year. The crop year in this district is from September to August.

Agricultural Education.

Cacao being our principal industry, the Government is endeavouring to improve the methods of cultivation, especially among the small peasant proprietors, of whom there is a very large number. These methods are being tried in many directions. The elementary principles of agriculture have been taught in all the primary schools since 1900, and school gardens are encouraged, in which the children take part in the cultivation. School shows are held annually, and prizes awarded for the best products. The teachers have received short courses of training, and have rendered enthusiastic assistance in the teaching of agriculture.

Higher agricultural education was introduced into the colleges in 1906 for senior students, and annual local examinations are conducted by the University of Cambridge.

The officers of the Department of Agriculture conduct experiments in agriculture, and disseminate agricultural information in various ways.

Two agricultural instructors are solely occupied in making daily visits to peasant proprietors and demonstrating to them practical methods of improving their cultivations.

Annual prizes are awarded to the best cultivations owned and worked by peasant proprietors under the supervision and guidance of the agricultural instructors.

Practical instruction in cacao cultivation is given at the Government estate to a limited number of students.

Home reading courses have been established, in which instruction is given by correspondence, and for which examinations are held annually. There are three stages in these courses—junior, intermediate, and senior—and corresponding certificates are awarded for proficiency.

Experiments in cacao cultivation are in progress in different districts and the results published. The field treatment of diseases is included in these experiments. The results are published in the official *Bulletin* and in special circulars.

The monthly official *Bulletin* is distributed free to local planters.

Quite recently the Government has approved of a proposal to grant two exhibitions of the value of £25 each to agricultural pupils. These are to be increased to four next year (1915), and to six in following years.

There is now under consideration a proposed extension of the present system of agricultural instruction on the estates owned by the Government. The period of training is to be divided as follows:—

First year at River Estate.

Second year at St. Augustine Estate and the Government Farm.

Third year at an approved outside estate.

The first year's course includes twenty lectures on plant life, propagation, and cultivation; ten lectures on soils and manures; forty lectures on cacao cultivation and preparation for the market, estate practice and management, estate book-keeping; ten lectures on fungoid diseases and treatment; ten lectures on insect pests and treatment.

The second year's course includes fifteen lectures on special crops; thirty on estate management and care of stock; ten on soils and manures; ten on fungoid diseases; ten on insect pests; ten on veterinary subjects; and five on farriery.

The lectures include practical demonstrations.

The third year is to be spent on an estate if suitable arrangements can be made.

The practical education that can be obtained on a large estate is most valuable, and many young men so educated are experts in cacao cultivation. The methods of cultivation practised on the estates may be described by some as empirical; but they have been successful, and they are the product of the experience of many years of patient and careful observation and consideration. They are truly scientific in their own way. Supplemented as they will be in the future by such methods as modern science and experience can suggest, I am firmly convinced that Trinidad will advance its world-wide reputation as a cacao-producing country. The proprietors, large and small, are imbued with the spirit of progressive methods, and this is proved by the fact that they now contribute to a special tax for agricultural purposes.

TABLE A.—YIELD IN PODS PER TREE IN TWO CONSECUTIVE YEARS ENDING AUGUST, 1911, AND AUGUST, 1912. AGE 25 TO 30 YEARS.

No.	1911	1912	No.	1911	1912	No.	1911	1912
2001	48	83	2035	43	101	2069	73	78
2002	46	49	2036	27	49	2070	8	2
2003	42	57	2037	86	142	2071	49	38
2004	141	172	2038	134	100	2072	16	12
2005	54	113	2039	42	38	2073	58	48
2006	72	97	2040	23	34	2074	83	112
2007	36	77	2041	27	30	2075	26	24
2008	167	267	2042	80	187	2076	21	24
2009	124	158	2043	61	81	2077	46	65
2010	102	167	2044	131	242	2078	19	29
2011	89	113	2045	3	7	2079	13	41
2012	123	205	2046	92	159	2080	84	152
2013	52	86	2047	62	71	2081	93	57
2014	34	68	2048	70	90	2082	28	30
2015	7	1	2049	136	140	2083	10	31
2016	106	79	2050	85	56	2084	34	84
2017	8	3	2051	97	87	2085	23	55
2018	34	85	2052	71	61	2086	32	70
2019	51	85	2053	5	13	2087	127	113
2020	61	80	2054	17	19	2088	64	78
2021	45	70	2055	38	58	2089	22	11
2022	113	49	2056	14	69	2090	269	290
2023	26	20	2057	28	74	2091	76	100
2024	64	39	2058	13	40	2092	113	96
2025	9	28	2059	11	22	2093	20	38
2026	118	124	2060	20	62	2094	38	6
2027	39	77	2061	38	50	2095	54	68
2028	39	60	2062	35	52	2096	30	65
2029	11	30	2063	50	30	2097	121	136
2030	52	34	2064	51	101	2098	18	34
2031	11	20	2065	25	55	2099	56	33
2032	11	4	2066	176	206	2100	47	66
2033	104	57	2067	15	45			
2034	55	50	2068	65	35			

SUMMARIZED AS IN TABLE C.

Pods per tree	Year 1911 Per cent.	Year 1912 Per cent.
Over 100	17	21
50 to 100	32	39
25 to 50	26	25
Under 25	25	15

TABLE B.—RIVER ESTATE, TRINIDAD. PLOTS UNDER MANURIAL EXPERIMENTS. FIELD 1.

Trees in each classified according to yield in 1911-12. Age of trees 12 years.

Plot	Number of trees	Lb. of dry cacao. 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total yield in pods	Percentage of trees yielding 2 lb. cacao and under
A*	49	24	8	6	5	3	1	2	—	—	—	—	—	—	—	1005	65
B	51	22	12	6	7	3	1	—	—	—	—	—	—	—	—	868	66
C	48	18	12	10	4	3	1	—	—	—	—	—	—	—	—	995	62
D	52	7	15	11	11	6	2	—	—	—	—	—	—	—	—	1574	42
E	50	7	10	15	3	10	2	1	2	—	—	—	—	—	—	1780	34
F	49	16	8	9	3	3	3	2	2	1	1	1	—	—	—	1678	49
G*	50	10	13	9	8	3	3	2	1	—	—	—	—	1	—	1628	46
H	47	13	15	5	5	6	3	—	—	—	—	—	—	—	—	1214	59
I	48	11	13	6	7	3	4	1	2	1	—	—	—	—	—	1516	50
J	50	16	10	12	4	5	1	—	—	1	—	—	—	—	1	1415	52
K	51	13	10	12	6	4	2	1	2	—	1	—	—	—	—	1560	45
L	49	28	8	7	4	—	1	—	1	—	—	—	—	—	—	719	73
M	50	19	13	12	1	1	1	3	—	—	—	—	—	—	—	1087	64
N	48	21	10	9	5	—	1	2	—	—	—	—	—	—	—	931	64
O	51	14	21	9	3	2	2	—	—	—	—	—	—	—	—	1071	68
P	52	11	14	9	5	3	2	4	—	3	1	—	—	—	—	1841	48
Q	48	5	8	8	8	4	4	4	2	4	1	—	—	—	—	2235	27
R	51	14	14	7	3	2	3	1	3	—	1	2	—	1	—	1813	55
S	49	22	12	6	2	5	—	2	—	—	—	—	—	—	—	1035	69
T	52	19	11	10	5	5	1	—	1	—	—	—	—	—	—	1200	57
U*	51	15	7	12	5	3	5	3	—	1	—	—	—	—	—	1577	43
V	52	4	8	12	9	9	6	3	1	—	—	—	—	-	—	2097	23
W	51	9	12	6	10	3	5	2	2	1	—	1	—	—	—	1946	41

* Control Plots.

TABLE C.—CACAO—TRINIDAD. NATURAL YIELD OF 748 TREES AT SOCONUSCO ESTATE.

September, 1912, *to August*, 1913.

Age of trees over 50 years.

Pods per tree	Trees: Number	Trees: Percentage of total	Pods (Total)	Average yield per tree: Pods	Average yield per tree: *Dry Cacao
					lb.
Over 100 ...	14	1·87	1,679	120·0	8·42
50 to 100 ...	100	13·37	6,484	64·8	4·55
25 to 50 ...	195	26·07	7,058	36·2	2·54
Under 25 ...	439	58·69	4,956	11·3	0·79

* 14·25 Pods yielded 1 lb. of Dry Cacao.

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TABLE D.—CACAO TREES.—RIVER ESTATE, TRINIDAD. FIELD 7.

Natural yield of 10 adjacent plots of (approx.) 54 trees each.

September, 1912, *to August*, 1913.

Age of trees 10 to 12 years.

Plot	Number of trees	Total No. of pods	No. of pods per tree
1	54	798	14·7
2	53	1490	28·1
3	56	1399	25·0
4	54	1165	21·5
5	56	1365	24·3
6	54	1570	29·0
7	52	1592	30·6
8	54	1705	31·5
9	53	2201	41·5
0	55	1986	36·1

TABLE E.—ANALYSIS OF SOILS FROM THE RIVER ESTATE. FIELD 7.

	Plot 1	Plot 3	Plot 5	Plot 8	Plot 10
	Per cent.	Per cent	Per cent.	Per cent.	Per cent.
Pebbles and sand ...	24·700	32·300	17·900	21·000	14·500
Composition of Fine Dry Soil.					
Organic matter* and combined water ...	4·946	4·907	4·448	3·984	3·986
Soluble silica	0·093	0·061	0·092	0·081	0·071
Oxides of iron and alumina	8·711	7·278	7·823	6·510	6·507
Lime (CaO)	0·046	0·039	0·069	0·057	0·057
Magnesia (MgO) ...	0·100	0·087	0·037	0·022	0·022
Potash (K_2O)	0·200	0·149	0·136	0·216	0·213
Soda (Na_2O)	0·062	0·068	0·087	0·065	0·052
Phosphoric anhydride (P_2O_5)	0·116	0·103	0·088	0·103	0·143
Sulphuric ,, (SO_3)	0·056	0·059	0·049	0·065	0·042
Chlorine (Cl)	0·011	0·022	0·019	0·034	0·022
Insoluble silica and silicates	85·659	87·227	87·152	88·863	88·885
*Containing total nitrogen	0·180	0·170	0·161	0·130	0·145
Available Plant Food.					
Potash (K_2O)	0·0054	0·0107	0·0121	0·0144	0·0133
Phosphoric anhydride (P_2O_5)	0·0063	0·0052	0·0059	0·0048	0·0166
Nitrogen as nitrates (NO_3)	0·0022	0·0036	0·0024	0·0038	0·0027

TABLE F.—CACAO TREES.—TRINIDAD ESTATES.

Natural yield of pods per tree from 21 plots in each district.

September, 1912, *to August*, 1913.

	Princes Town	Arima	Cunapo	Tamana	Santa Cruz	Talparo	Mont-serrat
	Pods	Pods	Pods	Pods	Pods	Pods	Pods
Maximum	31·21	23·83	30·65	27·00	35·27	54·50	55·93
Minimum	8·52	14·19	14·04	12·94	18·47	18·67	30·60
Difference	22·69	9·64	16·61	14·06	16·80	35·83	25·33

TABLE G.—CONTROL PLOTS.—TRINIDAD ESTATES.

District	Pods per Tree. Sept. to August		Percentage increase in 1912-13	Rainfall in District. Sept. to April		Age of Trees
	1911-12	1912-13		1911-12	1912-13	
				Inches	Inches	Years
Tamana ...	5·59 5·94	6·83 5·54	22 —	87·75	111·87	20 to 25
California ...	15·24 14·22 11·23	10·88 6·42 6·40	— — —	46·41	53·89	9 to 10
Princes Town ...	15·88 19·06	15·60 23·33	— 22	59·15	65·69	11
Cumuto ...	12·19 13·38	16·30 12·38	33 —	76·32	105·69	40
Talparo ...	21·53 21·37 25·68	29·16 27·43 30·11	35 28 17	64·89	99·51	30 to 40
Arima	13·84 14·46	17·62 19·62	27 35	65·08	82·45	55 to 60
Brasso	28·50 25·84 25·53	28·92 20·55 23·78	— — —	65·93	83·73	20 to 25
Santa Cruz ...	28·56 30·81	30·89 25·83	8 —	54·62	70·10	over 50

TABLE H.—RIVER ESTATE, TRINIDAD. FIELD 6.

Manured plots showing yield in pods per tree (September—August).

Plot	No. of trees	Pods per Tree			Manures used
		1910-11	1911-12	1912-13	
1	1,018	17	10·7	13·7	Sheep
2	500	31	31	25·3	Guano
3	520	29	32	24·0	Sheep and bird guano
4	202	30	31·8	28·0	Mulch
5	307	38	41	36·0	,, bone meal, K_2SO_4 and $(NH_4)_2SO_4$
6	300	41	42	36·1	,, basic slag, and K_2SO_4
7	1,000	41	42	43·7	Pen manure
8	504	20	28	28·6	Basic slag, K_2SO_4 and $(NH_4)_2SO_4$
9	500	9·8	7·4	5·2	Control

Rainfall Jan.-Dec.	1910	1911	1912	1913
	74·86	62·04	62·03	65·77 inches

TABLE I.—TRINIDAD ESTATES.

Number of pods per lb. of commercially dry cacao.

District	Total Number of pods	Lb. dry cacao	Number of pods per lb. of dry cacao
Tamana	10,312	834	12·36
California	23,668	1,812	13·06
Princes Town ...	29,342	2,259	12·99
Talparo	35,826	1,901	18·84
Arima	26,184	2,054	12·75
Chaguanas	16,045	1,174	13·67
Brasso	48,961	4,475	10·94
Santa Cruz	58,337	4,172	13·98
Diego Martin... ...	35,596	2,779	12·81
Sangre Grande ...	68,261	5,520	12·37

TABLE J.—RIVER ESTATE.

Number of bags (of 165 lb.) per 1,000 full-bearing trees obtained from different fields during the five years 1910 to 1914 (ending March 31).

Rainfall (*to December* 31) 1909=79·07 *in.*; 1910=74·86 *in.*; 1911=62·04 *in.*: 1912=62·03 *in.*; 1913=65·77 *in.*

	Field 1	Field 2	Field 3	Field 4	Field 5	Field 6	Field 7
Age of trees, years ...	12	30	30	30	30	30	8 to 80
Yield per 1,000 trees in bags of 165 lb., 1910 ...	11·75	15·37	19·41	17·43	19·29	5·58	8·00
,, ,, 1911 ...	12·86	21·03	23·09	17·57	20·85	10·65	7·99
,, ,, 1912 ...	10·45	13·07	13·16	20·00	19·19	12·18	4·93
,, ,, 1913 ...	11·18	7·07	7·93	13·94	15·16	9·31	5·01
,, ,, 1914 ...	11·52	11·35	11·81	17·47	18·48	11·66	5·28

	Field 8	Field 9	Field 10	Field 11	Field 12	Field 13
Age of trees, years	8 to 80	8 to 10	8 to 10	7 to 9	7 to 9	7 to 9
Yield per 1,000 trees in bags of 165 lb., 1910 ...	10·74	—	—	—	—	—
,, 1911 ...	16·33	—	—	—	—	—
,, 1912 ...	14·77	5·55	6·38	—	—	—
,, 1913 ...	11·65	6·72	4·19	4·19	4·79	2·75
,, 1914 ...	13·69	—	—	—	—	—

LA CULTURE DU CACAOYER AU MAYUMBE (CONGO BELGE).

Par J. Claessens.

Chef de Division au Ministère des Colonies de Belgique.

La Mayumbe est une région très accidentée et fortement boisée, coupée par de nombreux cours d'eau à courant généralement rapide. Il est séparé de l'océan par une zone côtière de 50 à 70 kilomètres de largeur, caractérisée par une végétation herbacée, à laquelle succède une zone de transition précédant la forêt.

L'altitude des terrains actuellement en culture varie entre 150 et 350 mètres, mais à l'est de la station de Ganda-Sundi se trouve un massif où nous avons constaté des altitudes de plus de 800 mètres.

La superficie utilisable pour des cultures est de plus de 5,000 kilomètres carrés. Sa population peut être évaluée à environ 180,000 habitants. La main-d'œuvre, sans être très abondante, a jusqu'à présent largement suffi à tous les besoins des planteurs. Les diverses plantations de cacao occupent approximativement une superficie de 3,500 hectares, comprenant des cacaoyères de 1 à 16 ans, pour lesquelles il est employé environ 3,000 travailleurs, coûtant, tous frais compris, de 70 a 90 centimes par jour.

Le cacaoyer a la réputation d'être une plante très exigeante quant à la nature du climat. En dehors de l'Afrique, les grands centres de production du cacao jouissent d'un climat spécial, caractérisé par une température élevée et par des chutes de pluie allant de 1,300 à 1,600 millimètres au minimum, régulièrement distribuées sur tous les mois de l'année.

La moyenne des températures maxima observées à la station agricole de Ganda-Sundi (Mayumbe) est de 29·47° C., tandis que la moyenne des minima est de 19·68° C.

L'expérience a démontré que l'action excessive de la chaleur sur les jeunes cacaoyers sans ombrage leur est nuisible, même pendant la saison des pluies. On a constaté, dans ces conditions, des mortalités atteignant jusqu'à 80 et même 90 pour cent. D'autre part, pendant les nuits parfois très fraîches des mois de la saison sèche, juillet, août, et septembre, pendant lesquels nous avons relevé des minima de 8 et même 7 degrés, les cacaoyers non protégés sont soumis à des rayonnements nocturnes intenses qui, sans être mortels, leur causent cependant un préjudice sérieux.

La caractéristique du régime des pluies au Mayumbe est l'existence de trois, quatre, parfois cinq mois de sécheresse. Il est des mois pendant lesquels il ne pleut pas du tout; pour d'autres mois on ne peut guère tenir compte des quelques rares petites pluies, dont l'ensemble mensuel ne dépasse pas 2 à 3 centimètres de hauteur. Ces pluies n'ont, en pleine saison sèche, qu'un effet direct peu marqué sur la végétation. Elles ont cependant l'avantage—et cela est très important—de maintenir très haut le degré hygrométrique de l'air. La quantité d'eau tombée annuellement à Ganda-Sundi oscille entre 1,193 et 1,827 millimètres. Il existe au Mayumbe une grande et une petite saison sèche. La première, très irrégulière et de durée variable, commence généralement vers la mi-mai, pour prendre fin vers la mi-septembre. La petite saison sèche, ou plutôt la saison de moindres pluies, d'une durée de quinze jours à trois semaines, se place entre décembre et février; elle est, comme la première, d'une très grande irrégularité. Pendant la grande saison sèche, il tombe fréquemment des pluies très fines, appelées par les indigènes "lisala." Ce sont des espèces d'épais brouillards qui déposent une rosée si abondante que parfois elle découle des feuilles et des toits.

Les vents sont parfois assez violents, surtout pendant la période des tornades, qui se place généralement en février-mars. Les grands arbres conservés par les planteurs comme porte-ombre sont assez souvent renversés et les dégâts qu'ils causent par leur chute sont parfois très importants.

Le degré hygrométrique de l'air oscille entre 64 et 94.

C'est grâce à cette atmosphère humide que les cacaoyers parviennent à supporter au Mayumbe les quatre ou cinq mois de la saison sèche. Pendant cette époque le ciel est presque toujours couvert et les brouillards sont très intenses, à tel point que le soleil arrive très difficilement à les percer. La conséquence la plus remarquable est que les cacaoyers ne perdent jamais leurs feuilles par suite de sécheresse.

Le grand nombre de roches qui se rencontrent au Mayumbe ont fourni par leur décomposition et leur remaniement par les eaux pluviales des sols de composition chimique et de constitution physique très différentes. Nous donnons ci-après trois analyses d'échantillons de terres prélevés dans une cacaoyère du Mayumbe âgée de 15 ans (méthode Woltman).

Cent parties de terre passées à travers le tamis de $\frac{1}{2}$ millimètre ont donné :

No. des échantillons	Sable	Argile	Silice soluble SiO_2	Oxyde de fer et d'alumine $Fe_2O_3 + Al_2O_3$	Azote total	Acide phosphorique P_2O_5	Chaux CaO	Potasse K_2O
1	80·93	14·03	0·05	3·93	0·140	0·030	2·62	0·202
2	81·32	14·97	0·06	9·25	0·080	0·038	2·17	0·259
3	34·19	59·20	0·05	3·37	0·080	0 038	0·97	0·315

L'échantillon n° 1 a été prélevé dans la vallée; le n° 2 au bas des collines et le n° 3 au sommet des collines, dans des endroits pierreux à 30 ou 40 centimètres de profondeur. Les deux premières terres situées en contrebas sont de bonnes terres à cacao, dont la composition physique est favorable. La troisème est trop argileuse. La composition chimique est déficitaire en acide phosphorique. Les proportions de chaux et de potasse sont particulièrement remarquables, en égard surtout à la culture prolongée qu'on a faite sur le terrain.

Au début, les planteurs choisissaient presque toujours les terrains des vallées, les replis des collines et les terres colluviales situées au bas de celles-ci, plus rarement les terrains fortement en pente et les sommets des montagnes. Ils recherchaient, avant tout, une belle forêt, sans se soucier de la constitution physique du sol. La présence de vigoureux arbres était, pour eux, une indication certaine de fertilité. Ils se contentaient d'abattre la forêt en réservant, comme porte-ombre, un certain nombre d'arbres choisis parmi les plus gros et ayant une couronne très élevée (Chlorophora, Eriodendron, Limba). Ils réservaient également des arbres utiles tels que : palmiers à huile, safoutiers, manguiers, kolatiers, Irvingia, etc.

Le coût d'un hectare de défrichement, opéré de cette façon, varie entre 250 et 400 francs, suivant la densité de la forêt, le coût et l'habileté de la main-d'œuvre.

Par la suite, certains planteurs constatèrent que les cacaoyers trop ombragés, tout en étant vigoureux, ne produisaient que très peu de fruits. C'est alors que les plus entreprenants commencèrent à enlever une partie des arbres d'ombrage, non sans endommager, ou détruire même complètement, bon nombre de cacaoyers. Ces planteurs avaient en partie raison, car l'ombrage trop intense est plutôt nuisible à la croissance normale des cacaoyers et surtout à la floraison et à la fructification; de plus il favorise le développement des maladies cryptogamiques. D'autre part, les cacaoyers se rejoignant par leur couronne couvraient complètement le sol et l'ombrage n'était plus, dès lors, absolument indispensable pour la protection de celui-ci. Nous sommes cependant d'avis, comme nous le verrons plus loin, qu'il est des plus utile de conserver un ombrage permanent judicieusement réglé.

La variété de cacao cultivée au Mayumbe est l'*Amelonado* ou *Amelouado*, originaire de San Thomé, qui paraît être celle la plus généralement cultivée à la côte occidentale d'Afrique. Elle n'atteint pas un fort développement et lorsqu'on la laisse croître librement elle forme sa couronne entre 1m. 20 et 1m. 60 de hauteur moyenne. Elle est très productive et résiste assez bien aux ennemis et aux maladies assez fréquents au Mayumbe.

Le semis en place est peu usité. Les jeunes plants sont le plus généralement élevés en pépinière, puis repiqués en paniers. Ce dernier procédé a donné de bons résultats.

Au début, les cacaoyers étaient placés à 3m. 50 et 4m. Aujourd'hui les planteurs ont une tendance à planter plus serré, ce qui semble préférable. Les trous sont presqu'invariablement creusés à 60 ou 70 centimètres de profondeur, ce qui, dans bien des cas, est absolument insuffisant.

Pour des raisons d'économie, les soins d'entretien accordés aux plantations sont très sommaires. Les herbes sont coupées trois ou quatre fois et éparpillées sur le sol. La taille se résume généralement à enlever le bois mort et à éclaircir les couronnes trop touffues.

La récolte ne présente rien de particulier. Elle est faite le plus souvent à l'aide d'une serpette bien aiguisée, attachée à une gaule de bois léger.

La fermentation du cacao du Mayumbe dure de quatre à huit jours, rarement davantage. Au sortir des bacs de fermentation, les graines sont mises directement au séchoir. Le lavage des fèves a été essayé, puis abandonné. Parfois les graines sont frottées entre de vieux sacs pour leur enlever l'excès de mucilage encore adhérent, mais la perte de poids ne semble pas être compensée par le gain de la qualité.

Les planteurs du Mayumbe utilisent plusieurs procédés de séchage: (*a*) Le séchage au soleil, sur des aires cimentées, abritées en cas de pluies par des toits roulants ou des bâches imperméables, ou encore des plateaux roulants, ou des claies qui sont rentrées dans des bâtiments *ad hoc*.

(*b*) Le séchage artificiel par des fours spéciaux qui, à notre connaissance, ne sont utilisés qu'au Mayumbe. Ce système de fours, inventé par le R. P. De Cleene, provincial des Missions de Scheut au Congo, consiste essentiellement en une voûte romane sur laquelle repose une aire cimentée où l'on place le cacao à sécher. La voûte est percée, sur les côtes et sur le dessus, d'une quantité de trous ingénieusement combinés, qui amènent la chaleur sous l'aire de séchage où le cacao est continuellement remué.

Parmi les principaux ennemis du cacaoyer au Mayumbe, il convient de citer notamment le *Sahlbergella singularis* ou punaise du cacao, qui occasionne des dégâts importants. Ce dangereux ennemi peut, si l'on n'y prend garde, faire périr des milliers d'arbres en très peu de temps. Dans certaines plantations, les rats occasionnent également des dégâts appréciables.

Parmi les maladies cryptogamiques, la maladie du tronc ou " Dieback," cause parfois des pertes très importantes. Bon nombre de mortalités constatées dans les plantations sans ombrage doivent être mises sur le compte du *Cephaleuros virescens*. Les maladies des fruits, *Phytophthora Faberi* et *Colletotrichum* sp. sont aussi des ennemis dangereux, qui enlèvent parfois au planteur une partie de ses bénéfices.

Une étude sur ces divers ennemis et maladies des cacaoyers du Mayumbe a été faite par MM. Vermoesen, mycologiste, directeur du Jardin botanique d'Eala, et Mayné, entomologiste.

La culture du cacaoyer au Mayumbe est entre les mains des sociétés et des particuliers; les indigènes ne s'en occupent pas. Les premiers plants ont été mis en en terre vers 1895. L'étendue actuellement en culture peut être évaluée à environ 3,500 hectares, dont l'entièreté n'est pas encore en rapport. Plusieurs sociétés ont obtenu des résultats très encourageants, certaines années même très satisfaisants. Le rendement moyen par arbre varie entre 500 et 1,200 grammes de cacao commerçable. Des arbres produisant 2, 3 et même 4 kg. ne sont pas rares.

La quantité de produits exportés du Mayumbe était de 14,400 kg. en 1902 et elle atteignit 967,800 kg. en 1913.

Pour réussir au Mayumbe, la culture du cacao exige des soins et certaines précautions que nous énumerons ci-après :

(1) Il faut planter de préférence dans les vallées et dans les terres colluviales, situées à la partie supérieure des collines. La partie inférieure de celles-ci est souvent inutilisable à cause de son excès d'argile et de sa faible teneur en éléments utiles. En tous cas de nombreux sondages s'imposent dans les recherches de terrains.

(2) Lors du déboisement du sommet des collines, il

faut avoir soin de conserver un manteau de forêts débordant des deux côtés de la crête. Dans les bas-fonds, à sous-sols imperméables, il faut maintenir la forêt. Il est très utile de réserver de distances en distances des bandes de forêt en guise de brise-vent. Ces divers noyaux de forêts provoquent la chute des pluies, favorisent les brouillards et conservent à l'atmosphère ambiante l'humidité si utile au cacaoyer.

(3) Il importe beaucoup au Mayumbe de protéger le sol le plus tôt possible après la dernière incinération de la forêt, en semant une plante de couverture à croissance rapide, de préférence une légumineuse. Le *Leucæna glauca* possède l'avantage de croître sous un demi-ombrage.

(4) Une plantation serrée couvrant le sol très rapidement, il est nécessaire de ne pas trop écarter les plants. Une bonne distance à observer pour la variété *Amelonado* est 3m. ou 3m. 50 maximum dans les vallées fertiles. Dans les terres meubles légères des trous de om. 60 × om. 60 sont amplement suffisants. Par contre dans les terres très fortes ces dimensions sont insuffisantes et des fosses d'un mètre cube sont nécessaires, sinon les racines atteignent très rapidement les parties de terres non remuées et la plante meurt. Des plantations faites de la sorte coûtent cher, mais, par la suite, elles compensent largement les sacrifices consentis.

Si les conditions de transport le permettent, l'usage d'une certaine quantité d'engrais appropriés est à conseiller, pour pousser les jeunes cacaoyers à ombrager le sol le plus rapidement possible.

La mise en place des plants doit être surveillée de très près, si l'on veut éviter les pertes parfois très importantes provenant d'un enfouissement trop profond des jeunes cacaoyers. Les plants ne doivent pas être enterrés plus profondement dans le sol qu'elles ne l'étaient dans la pépinière.

(5) Pour ce qui est de la question de l'ombrage, nous ne nous refusons pas à admettre que la culture du cacaoyer soit possible sans ombrage définitif au Mayumbe, dans des conditions déterminées et par des procédés culturaux appropriés; nous pensons même que ce système

mérite de retenir l'attention et devrait être expérimenté, mais, et nous insistons sur ce point, c'est une erreur profonde de priver les plantations d'ombrage dans leur jeune âge. Cet ombrage indispensable aux jeunes cacaoyers est plus nécessaire encore au début de la plantation, pour protéger le sol, dépourvu de toute végétation, contre les rayons ardents du soleil et l'action plus néfaste encore des eaux pluviales. Ces dernières entraînent vers les bas-fonds le peu d'humus qui recouvre les sols du Mayumbe et constitue leur principale richesse.

Lorsque les cacaoyers auront fourni par eux-mêmes le couvert complet du sol, l'ombrage pourra ne plus être absolument indispensable, mais nous sommes entièrement convaincus qu'un ombrage artificiel bien réglé sera toujours, au point de vue économique, des plus utile pour les plantations du Mayumbe, qui ont à supporter 4 à 5 mois de saison sèche.

Il est reconnu que les plantations sans ombrage permanent rapportent plus vite et plus, mais aussi qu'elles s'épuisent plus rapidement. Il appartient aux planteurs et aux directeurs de sociétés d'examiner quel est le système le plus avantageux.

Le bananier plantain convient très bien pour remplir l'office de porte-ombre pendant les premières années. Il appauvrit un peu les couches supérieures du sol, mais en retour il procure un ombrage très salutaire aux jeunes cacaoyers. Une bonne pratique consiste à planter les bananiers au début de la saison des pluies en même temps que l'on sème la plante de couverture dont il a été question plus haut. De cette façon le cacaoyer peut être planté immédiatement après la petite saison sèche, alors que les bananiers, dans les bons terrains, ont déjà atteint un développement suffisant pour protéger efficacement les jeunes plants.

Dans les cacaoyères où l'on ne réserve pas les arbres de la forêt comme ombrage permanent, il ne sera pas exagéré de planter au moins un bananier par quatre cacaoyers. Quand on ne peut se procurer les bananiers en nombre suffisant, on peut partiellement les remplacer par des pois cajan, qui procurent aussi un abri convenable. Si le sol est suffisamment riche, il y aurait lieu de planter des bananiers produisant des fruits de dessert propres à l'exportation.

L'ombrage permanent peut ne pas être indispensable. mais nous sommes entièrement convaincus qu'il est très utile et plus économique sous un climat à saison sèche comme celui du Mayumbe, où il est des plus difficile de se procurer des engrais et d'exécuter des façons de culture nombreuses qui sont fort coûteuses. Nous ne sommes pas partisans de conserver comme ombrage les arbres de la forêt. Maïs si le planteur préfère adopter ce système, qui est pratiqué à San Thomé, nous croyons qu'il vaut mieux ne pas maintenir les plus grands spécimens et donner la préférence à des arbres de dimensions moyennes, ou même à des balivaux peu développés, et parmi eux de choisir ceux qui, lors d'un abatage éventuel, occasionneraient le moins de dégâts par leur chute. Il va de soi que les arbres utiles, Élæis, safoutiers, kolatiers, Irvingia, et autres encore, seront conservés. Les arbres géants, qui sont habituellement maintenus dans ce but, outre les dégâts qu'ils occasionnent par leur chute, produisent des racines généralement traçantes et pourvues d'un chevelu abondant, qui enlèvent au sol, au détriment du cacaoyer, une quantité importante de matières nutritives et de plus épuisent la réserve d'eau si nécessaire cependant en saison sèche.

Il est préférable, à notre avis, d'abattre complètement la forêt et de replanter des arbres d'ombrage appropriés. Nous préférons l'ombrage bas à l'ombrage élevé qui fait filer les jeunes cacaoyers. Jusqu'à présent, aucune expérience sérieuse n'a été faite pour rechercher les arbres d'ombrage auxquels il convient d'accorder la préférence. On pourrait essayer au Mayumbe les espèces suivantes: *Inga Saman*, *Albizzia stipulata* et *A. mollucсana* en donnant la préférence aux derniers. Une combinaison qui nous paraît devoir être recommandée consiste à faire des plantations mixtes de cacaoyers et de palmiers à huile ou de cocotiers.

(6) Le planteur du Mayumbe se préoccupe peu de la taille du cacaoyer, qui cependant, si elle est judicieusement faite, peut avoir les plus heureux résultats sur la production et la longevité des arbres. Elle doit se limiter

à l'enlèvement des gourmands et à la formation d'une couronne régulière et aux branches bien équilibrées et bien aérées. Nous avons vu mutiler des champs entiers de cacaoyers par l'enlèvement inconsidéré d'un trop grand nombre de branches de tous genres. Outre le danger que présente cette pratique défectueuse, en propageant les maladies par les nombreuses plaies occasionnées, elle a pour résultat de retarder et de réduire la production des cacaoyers qui souffrent de l'amputation brusque d'une partie de leurs organes actifs.

(7) A part quelques pulvérisations de bouillie bordelaise et de badigeonnages à l'aide d'un antiseptique des plaies occasionnées par la taille, la lutte contre les ennemis du cacaoyer est pour ainsi dire nulle. Ce n'est que depuis ces derniers temps que les enveloppes de cabosses sont assez régulièrement incinérées : elles étaient autrefois abandonnées dans les plantations, sans traitement spécial pour prévenir la propagation des maladies contagieuses; celles-ci existent dans presque toutes les plantations.

La culture du cacaoyer bien comprise peut être rémunératrice au Mayumbe, ainsi que l'ont d'ailleurs prouvé plusieurs sociétés qui distribuent des dividendes parfois très satisfaisants.

ESTUDIOS SOBRE EL CULTIVO DEL CACAO EN FERNANDO POO.

Por Emilio Gómez Flores.

Ingeniero Jefe del Servicio Agronómico do Las Palmas.

Introduccion.

Los datos recogidos durante el viaje de estudio agronómico realizado en la Guinea Española por iniciativa del Jefe de la Sección Colonial del Ministerio de Estado; nos permitio recoger meustras de tierras y frutos, cuyos analisis practicados en el Laboratorio del Servicio Agronómico de Las Palmas (Gran Canaria) consignamos a continuación; aportando este modesto concurso al tercer Congreso de Agronomia Tropical.

La estructura geológica de Fernando Poó; acusa sin género de duda el predominio de rocas de naturaleza basáltica, que facilmente pueden clasificarse en dos grupos; Basalto de olivina normal y basalto sin olivina o labradorita augitica. Con ellos aparecen; fonolitas, feldespaticas, confirmando la hipótesis de Mr. Lowthian Green, ligando la cadena de las Islas Azores, Canarias, Cabo Verde, Fernando Poó, Príncipe, Santo Thomé, Annabón y Santa Elena.

Y en efecto: Situadas en alineación que difiere poco de la recta y que visiblemente corresponde a una paraclasa o linea de fractura; forma esta un arco de círculo máximo que corta al ecuador bajo un ángulo de 60 grados, comprobando la deformación tetraedrica de la corteza terrestre primitivamente esférica.

A mayor abundamiento no faltan en las islas citadas, así como en Fernando Poó: ejemplares similares de traquitas, doleritas, augitas, feldespato, granito, plagiaclasa, mica, gneis, talcocita, cuarcitas pizarrosas cloriticas, maclas de la periclina, magnetita en cubos y octaedros bien determinados de extructura afanitica, apitita, piroxeno, labradorita carecterizada por su dicroismo, lavas, tobas y lapillis.

El producto de la descomposición de estas rocas primordiales, constituidas por productos del tipo basáltico o por tobas formadas de materiales detriticos de las mismas; conduce a establecer el predominio de las tierras fuertemente arcillosas en los territorios de la Guinea Española; abundantes óxidos de hierro, acido fosfórico, poca potasa y escasisima proporción de cal. Y esto es lo que confirman los analisis que transcribimos a continuación: —

Finca "La Barcelonesa," San Carlos, Fernando Poó de los Srs. Ris y Torres.

Analisis de una Muestra de Tierra.

Mecanico.

Elementos gruesos	23·00
Id. finos	977·00
	1,000·00

Fisico.

Arena gruesa	78·50
Id. fina	241·70
Arcilla	560·80
Caliza	1·30
Materia orgánica	69·70
Humedad	48·00
	1,000·00

Quimico.

Nitrógeno	1·32 por 1,000
Acido fosfórico	1·74 ,,
Potasa	0·80 ,,
Cal	0·76 ,,

"Mision de Banapá," Misioneros del Inmaculado Corazon de Maria.

Analisis de una Muestra de Tierra.

Mecanico.

Elementos gruesos	18·00
Id. finos	982·00
	1,000·00

FISICO.

Arena gruesa	34·20
Id. fina	234·30
Arcilla	558·70
Caliza	7·70
Materia orgánica	100·50
Humedad	64·60
	1,000·00

QUIMICO.

Nitrógeno	2·27	por 1,000
Acido fosfórico	8·32	,,
Potasa	0·88	,,
Cal	4·56	,,

"MISION DE LA CONCEPCION," MISIONEROS DEL INMACULADO CORAZON DE MARIA.

Analisis de una Muestra de Tierra del Suelo.

MECANICO.

Elementos gruesos	2·00
Id. finos	998·00
	1,000·00

FISICO.

Arena gruesa	0·00
Id. fina	326·80
Arcilla	509·30
Caliza	7·20
Materia orgánica	109·00
Humedad	47·70
	1,000·00

QUIMICO.

Nitrógeno	2·21	por 1,000
Acido fosfórico	6·80	,,
Potasa	0·23	,,
Cal	4·22	

"MISION DE LA CONCEPCION," MISIONEROS DEL INMACULADO CORAZON DE MARIA.

Analisis de una Muestra de Tierra del Subsuelo.

MECANICO.

Elementos gruesos	0·00
Id. finos	1,000·00
	1,000·00

FISICO.

Arena gruesa	0·00
Id. fina	260·60
Arcilla	587·40
Caliza	1·50
Materia orgánica	104·00
Humedad	46·50
	1,000·00

QUIMICO.

Nitrógeno	1·89 por 1,000
Acido fosfórico	6·23 ,,
Potasa	0·25 ,,
Cal	0·90 ,,

FINCA DE DON MAXIMILIANO JONES, SAN CARLOS.

Analisis de una Muestra de Tierra.

MECANICO.

Elementos gruesos	19·00
Id. finos	981·00
	1,000·00

FISICO.

Arena gruesa	30·30
Id. fina	242·20
Arcilla	621·00
Caliza	0·98
Materia orgánica	64·00
Humedad	41·52
	1,000·00

QUIMICO.

Nitrógeno	1·96 por 1,000
Acido fosfórico	2·04 ,,
Potasa	1·10 ,,
Cal	3·24 ,,

FINCA "ANGELA," SAN CARLOS, FERNANDO POÓ.

Analisis de una Muestra de Tierra del Suelo.

MECANICO.

Elementos gruesos	25·00
Id. finos	975·00
	1,000·00

FISICO.

Arena gruesa	9·00
Id. fina	445·00
Arcilla	367·00
Caliza	9·00
Materia orgánica	126·00
Humedad	53·00
	1,000·00

QUIMICO.

Nitrógeno ...	2·34 por 1,000
Acido fosfórico	3·78 ,,
Potasa ...	1·12 ,,
Cal ...	5·31 ,,

FINCA "ANGELA," SAN CARLOS, FERNANDO POÓ.

Analisis de una Muestra de Tierra del Subsuelo.

MECANICO.

Elementos gruesos ...	0·00
Id. finos ...	1,000·00
	1,000·00

FISICO.

Arena gruesa	0·00
Id. fina	292·80
Arcilla ...	537·00
Caliza ...	3·70
Materia orgánica	93·00
Humedad ...	73·50
	1,oco·00

QUIMICO.

Nitrógeno	1·56 por 1,000
Acido fosfórico	1·74 ,,
Potasa ...	indicios
Cal ...	2·25 por 1,000

FINCA "MERCEDES," FERNANDO POÓ DE LOS SRS. MONTEIRO Y COMPAÑIA.

Analisis de una Muestra de Tierra.

MECANICO.

Elementos gruesos ...	11·00
Id. finos ...	989·00
	1,000·00

FISICO.

Arena gruesa	70·50
Id. fina	445·20
Arcilla ...	347·50
Caliza ...	5·70
Materia orgánica	79·50
Humedad ...	51·60
	1,000·00

QUIMICO.

Nitrógeno ...	2·17 por 1,000
Acido fosfórico	8·69 ,,
Potasa ...	0·55 ,,
Cal ...	3·33 ,,

Finca "Concepcion," Fernando Poó, de la Compañia Trasatlantica.

Analisis de una Muestra de Tierra del Suelo.

Mecanico.

Elementos gruesos	0·00
Id. finos	1,000·00
	1,000·00

Fisico.

Arena gruesa	0·00
Id. fina	325·50
Arcilla	520·40
Caliza	3·50
Materia orgánica	107·60
Humedad	43·00
	1,000·00

Quimico.

Nitrógeno	1·39 por 1,000
Acido fosfórico	1·61 ,,
Potasa	1·67 ,,
Cal	2·02 ,,

Finca "Concepcion," Fernando Poó, de la Compañia Trasatlantica.

Analisis de una Muestra de Tierra del Subsuelo.

Mecanico.

Elementos gruesos	0·00
Id. finos	1,000·00
	1,000·00

Fisico.

Arena gruesa	0·00
Id. fina	192·20
Arcilla	653·20
Caliza	2·40
Materia orgánica	96·00
Humedad	56·20
	1,000·00

Quimico.

Nitrógeno	1·57 por 1,000
Acido fosfórico	3·41 ,,
Potasa	0·19 ,,
Cal	1·43 ,,

FINCA DE "SAN ANTONIO" FERNANDO POÓ, DE LA COMPAÑIA TRASATLANTICA.

Analisis de una Muestra de Tierra del Suelo.

MECANICO.

Elementos gruesos	74·00
Id. finos	926·00
	1,000·00

FISICO.

Arena gruesa	102·20
Id. fina	452·60
Arcilla	234·30
Caliza	12·30
Materia orgánica	134·50
Humedad...	64·10
	1,000·00

QUIMICO.

Nitrógeno	2·29	por 1,000
Acido fosfórico	4·02	,,
Potasa	1·32	,,
Cal	6·74	,,

FINCA DE "SAN ANTONIO" FERNANDO POÓ, DE LA COMPAÑIA TRASATLANTICA.

Analisis de una Muestra de Tierra del Subsuelo.

MECANICO.

Elementos gruesos	133·00
Id finos	867·00
	1,000·00

FISICO.

Arena gruesa	110·00
Id. fina	443·80
Arcilla	264·50
Caliza	8·50
Materia orgánica	101·50
Humedad...	71·70
	1,000·00

QUIMICO.

Nitrógeno...	1·70	por 1,000
Acido fosfórico	3·29	,,
Potasa	1·02	,,
Cal	4·43	,,

FINCA DE "NUESTRA SEÑORA DE LA PAZ," FERNANDO POÓ DE LA COMPAÑIA TRASATLANTICA.

Analisis de una Muestra de Tierra del Suelo.

MECANICO.

Elementos gruesos	2·00
Id. finos	998·00
	1,000·00

FISICO.

Arena gruesa	59·60
Id. fina	393·00
Arcilla	347·50
Caliza	2·70
Materia orgánica	119·50
Humedad...	77·70
	1,000·00

QUIMICO.

Nitrógeno...	2·32 por 1,000
Acido fosfórico	5·77 ,,
Potasa	1·26 ,,
Cal	1·62 ,,

FINCA DE "NUESTRA SEÑORA DE LA PAZ," FERNANDO POÓ DE LA COMPAÑIA TRASATLANTICA.

Analisis de una Muestra de Tierra del Subsuelo.

MECANICO.

Elementos gruesos	0·00
Id. finos	1,000·00
	1,000·00

FISICO.

Arena gruesa	47·50
Id. fina	337·00
Arcilla	414·10
Caliza	1·40
Materia orgánica	121·00
Humedad...	79·00
	1,000·00

QUIMICO.

Nitrógeno	2·25 por 1,000
Acido fosfórico	5·44 ,,
Potasa	0·65 ,,
Cal	0·82 ,,

FINCA DE "CASTELL," BASILÉ, FERNANDO POÓ.

Analisis de una Muestra de Tierra del Subsuelo.

MECANICO.

Elementos gruesos	94·00
Id. finos	906·00
	1,000·00

FISICO.

Arena gruesa	0·00
Id. fina	219·20
Arcilla	627·40
Caliza	2·80
Materia orgánica	86·10
Humedad	64·50
	1,000·00

QUIMICO.

Nitrógeno	1·40	por 1,000
Acido fosfórico	2·42	,,
Potasa	0·24	,,
Cal	2·15	,,

FINCA DE "CASTELL," BASILÉ, FERNANDO POÓ.

Analisis de una Muestra de Tierra del Suelo.

MECANICO.

Elementos gruesos	20·00
Id. finos	980·00
	1,000·00

FISICO.

Arena gruesa	0·00
Id. fina	293·50
Arcilla	540 80
Caliza	3·10
Materia orgánica	104·00
Humedad	58·60
	1,000·00

QUIMICO.

Nitrógeno...	2·15	por 1,000
Acido fosfórico	4·21	,,
Potasa	1·49	,,
Cal	2·96	,,

"MISION FRANCESA DE BATA," GUINEA ESPAÑOLA.

Analisis de una Muestra de Tierra.

MECANICO.

Elementos gruesos	86·00
Id. finos	914·00
	1,000·00

FISICO.

Arena gruesa	590·40
Id. fina	124·40
Arcilla	220·30
Caliza	1·40
Materia orgánica	52·50
Humedad	11·00
	1,000·00

QUIMICO.

Nitrógeno ...	0·78 por 1,000
Acido fosfórico	0·16 ,,
Potasa	0·18 ,,
Cal	0.76 ,,

"MISION DE BANAPA," FERNANDO POÓ.

Analisis de una Muestra de Cacao.

Celulosa bruta ...	1·75
Materia mineral	3·21
Id. grasa	39·00
Id. proteica	13·26
Id. hidrocarbonada ...	35·56
Humedad	7·22
Total ...	100·00
Riqueza en teobromina ...	1·73 por 100

FINCA "MERCEDES," DE LOS SRS. MONTEIRO Y CA.

Analisis de una Muestra de Cacao.

Celulosa bruta ...	1·92
Materia mineral	3·10
,, grasa ...	33·00
,, proteica	11·19
,, hidrocarbonada ...	44·54
Humedad	6·25
Total ...	100·00
Riqueza en teobromina ...	1·55 por 100

FINCA "SAN ANTONIO," DE FERNANDO POÓ, PROPIEDAD DE LA COMPAÑIA TRASATLANTICA DE BARCELONA.

Analisis de una Muestra de Cacao.

Celulosa bruta ...	2·06
Materia mineral	3·00
,, grasa ...	31·50
,, proteica	10·56
,, hidrocarbonada ...	46·88
Humedad	6·00
Total ...	100·00
Riqueza en teobromina ...	1·39 por 100

FINCA "CONCEPCION," DE FERNANDO POÓ, PROPIEDAD DE LA COMPAÑIA TRASATLANTICA DE BARCELONA.

Analisis de una Muestra de Cacao.

Celulosa bruta ...	1·84
Materia mineral	3·25
,, grasa ...	35·40
,, proteica	11·81
,, hidrocarbonada ...	41·70
Humedad	6·00
Total ...	100·00
Riqueza en teobromina ...	1·59 por 100

FINCA "NUESTRA SEÑORA DE LA PAZ," DE FERNANDO POÓ, PROPIEDAD DE LA COMPAÑIA TRASATLANTICA DE BARCELONA.

Analisis de una Muestra de Cacao.

Celulosa bruta	1·90
Materia mineral	2·91
,, grasa	31·12
,, proteica	10·75
,, hidrocarbonada	47·47
Humedad	5·85
Total ...	100·00
Riqueza en teobromina	1·42 por 100

"MISION FRANCESA DE BATA," GUINEA ESPAÑOLA.

Analisis de una Muestra de Cacao.

Celulosa bruta	1·76
Materia mineral	3·36
Id. grasa	38·40
Id. proteica	12·60
Id. hidrocarbonada	37·33
Humedad	6·55
Total ...	10·000
Riqueza en teobromina	1·61 por 100

COMPOSICIÓN MEDIA DEL FRUTO PRODUCIDO POR 625 PLANTAS PRODUCIENDO 1,000 KILOS DE CACAO COMERCIAL.

	Capsulas o piñas	Cacao	Fruto completo
Potasa	55·35	11·22	66·57
Nitrógeno ...	13·70	19·65	33·36
Acido fosfórico ...	4·00	8·54	12·73
Magnesia ...	6·58	4·48	11·42
Cal	7·59	1·65	9·25

CONSUMO ANUAL MEDIO POR HECTÁREA DE 625 PLANTAS PRODUCIENDO 1,000 KILOS DE CACAO COMERCIAL.

Potasa	107·24 kilos
Cal	55·52 ,,
Nitrógeno...	51·52 ,,
Magnesia	24·15 ,,
Acido fosfórico	19·29 ,,

CONCLUSIONES.

De los datos que anteceden puede establecerse sin temor alguno, que la caracteristica de la composición de las tierras de cultivo de Fernando Poó; está determinada por falta de cal y siendo elemento indispensable para las necesidades de la producción del cacao; es necesario suplirla directamente, para evitar la degeneración de las plantas y disminución gradual de las cosechas.

Además la carencia de cal, predispone al cacao a ser atacado por el ascomyceto, *Botryodiplodia theobromæ* que ocasiona la terrible enfermedad conocida por "piña negra" cada dia mas extendida en el cultivo en la isla de Fernando Poó. La practica de depositar los pedazos de piña o envolvente del cacao, en montones que facilmente entran en fermentación; es forzoso desterrarla en absoluto y proceder a enterrar las piñas, despues de haberlas adicionado con una espesa lechada de cal.

Al S.O. de la isla de Corisco, existen grandes canteras de rocas calizas con una riqueza de 70 por 100 de carbonato de cal. Este yacimiento único en el Africa ecuatorial; permitiria la exportación de la piedra de cal, tal como sale de la cantera propiedad de los Misioneros del Corazón de Maria y resolveria el problema de transportarla a las fincas de cultivo, en las cuales y en hornos apropiados, se produciria facilemente la cal viva; sin los riesgos y pérdidas que hoy ocasiona la rotura de los envases de artículo tan delicado.

TOBACCO.

THE PRODUCTION OF TOBACCO IN NYASALAND.

By J. Stewart J. McCall, P.A.S.I., C.D.A.Glas.

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The culture of "bright" tobacco in Nyasaland is a comparatively new industry, and the first exports of locally grown tobacco are recorded in the returns of the Customs Department for the financial year 1899, when the total export amounted to 2,240 lb. of cured tobacco, valued locally at £47 sterling.

During the years 1900 to 1904 there was a steady increase both in acreage and export, the former increasing from 69 to 944, and the latter from 4,480 lb. to 28,754 lb. of cured tobacco, valued locally at £479.

From the commencement of our export until the year 1904 (1899-1904) Nyasaland tobacco found a ready market in South Africa, and no serious attempt was made to gain a footing in the London market, but at this juncture rearrangement of Customs regulations in South Africa and the application of an import duty on Nyasaland tobacco by the South African Customs authorities soon placed our tobacco at such a disadvantage against the South African product that we had to seek a footing on the home market, with the result that during this temporary set-back our acreage rapidly fell from 944 in 1904 to 421 in 1905.

In April, 1908, the Imperial Tobacco Company, after examining samples of our crop, took such interest in the product that they established a factory at Limbe, near Blantyre, and a considerable tobacco industry rapidly developed throughout the Shire Highlands, the acreage increasing from 421 in 1905 to 10,496 in 1913, and the export for the corresponding period from 56,826 lb., valued locally at £945, to the substantial figures of 3,763,014 lb., valued at £94,167 15s. 6d., and equal in weight to nearly 4 per cent. of the average annual consumption of tobacco in Great Britain.

Climate.

In Nyasaland the cultivation of tobacco is confined to the uplands, and the crop grows luxuriantly at elevations varying between 1,000 ft. and 3,500 ft. above sea-level, and can be grown at altitudes too high for cotton, but, unlike the latter, it suffers more from drought than from excessive rain in the growing priod.

For a tropical or sub-tropical crop tobacco has justly proved itself to be hardy, and, apart from hail or excessive rain towards harvest, is able to withstand wide ranges of temperature.

The two most important climatic factors for a successful tobacco season in Nyasaland are: firstly, a period of steady rain and cloud during planting; and, secondly, a quick termination of the rains when the crop is ready to harvest. In the absence of typical planting weather, it is practically impossible to get a stand of young plants in the fields when transplanting from the nurseries; the hot tropical sun quickly dries up the young plants before they can fix their roots, even although the activity of young tobacco roots is so remarkable as to make them capable of withstanding a whole week's drought after less than twenty-four hours of dull weather.

The second climatic factor already referred to may render a splendid crop valueless by encouraging mildew and secondary growth, and a week of cold, wet, and cloudy weather after the leaves have been partly ripened by sunshine is always fatal to good results.

The following table shows the Zomba rainfall in inches during the tobacco-growing seasons of 1908-09 to 1911-12; this rainfall may be taken as slightly in excess of the average of most tobacco-growing districts of the Shire Highlands, but is quite suitable for the production of "bright" tobacco, which is actually grown with success in the immediate vicinity of Zomba at an elevation of approximately 3,000 ft. above sea-level.

	December	January	February	March	April	May
1908-1909	4·27	9·64	10·86	5·61	4·67	0·99
1909-1910	21·18	10·77	13·41	6·13	3·97	4·50
1910-1911	10·45	11·79	10·14	2·27	0·01	0·61
1911-1912	19·86	8·87	6·04	13·24	4·67	2·66

From May to September the rainfall rapidly diminishes to *nil*, and in late October or early November the little rains set in, gradually leading up to the heavy rains of December-January.

During the period in which tobacco is cultivated the shade temperature fluctuates between 55° and 90° F.; but, on the average, warmer weather and more sunshine is experienced in December, January, and February than in March, April, and May, the major portion of the crop ripening in the dry, cold, bright weather of April and May.

Soils.

The tobacco soils of the Shire Highlands vary from light sandy loams to stiff red clays, and are characterized by being comparatively rich in potash, normal to slightly deficient in phosphates, and poor in nitrogen.

Two analyses conducted by the Imperial Institute of what the writer considers to be typical tobacco or cotton soils of the Zomba District are herewith appended.

Sample A.

		Total.	Soluble in hydrochloric acid	"Available" constituents, *i.e.*, soluble in 1 per cent. citric acid solution	
		Per cent.	Per cent.	Per cent.	lb. per acre
Lime ...	... CaO	—	0·31	—	—
Magnesia ...	... MgO	—	0·31	—	—
Potash ...	... K_2O	1·04	0·33	0·036	936
Soda ...	... Na_2O	0·11	0·08	0·033	856
Phosphoric acid	... P_2O_5	0·25	—	0·012	312
Nitrogen ...	... N	0·066*	—	—	—
Carbon dioxide	... CO_2	0·02	—	—	—
Loss on ignition	... —	9·55	—	—	—

* Equivalent to 1,716 lb. of nitrogen per acre.

SAMPLE B.

		Total	Soluble in hydrochloric acid	"Available" constituents, *i.e.*, soluble in 1 per cent. citric acid solution	
		Per cent.	Per cent.	Per cent.	lb. per acre
Lime	CaO	—	0·19	—	—
Magnesia	MgO	—	0·34	—	—
Potash	K_2O	0·68	0·23	0·062	1,488
Soda	Na_2O	0·10	0·08	0·023	552
Phosphoric acid ...	P_2O_5	0·27	—	0·023	552
Nitrogen	N	0·05*	—	—	—
Carbon dioxide ...	CO_2	0·01	—	—	—
Loss on ignition ...	—	10·70	—	—	—

* Equivalent to 1,200 lb. of nitrogen per acre.

The yield per acre and quality of the crop depend very largely on the nitrogen content of the soil, and the heaviest crops are generally reaped off virgin land, but the tobacco plant is such a voracious feeder that four years' continuous tobacco cultivation practically reduces all Nyasaland soils, except the heaviest clays, to such a state of poverty as to render them useless for tobacco growing until they have been green manured for a year, or allowed to revert to natural grass and weed for not less than two years.

The percentage of bright leaf in a crop is usually in adverse proportion to its luxuriance, and the brightest tobacco is produced on the lightest soil or loams deficient in nitrogen; but this class of bright, small yellow leaf, without body and specially suitable for cigarettes, is never profitable to the planter, the yield per acre seldom exceeding 300 lb.

A golden leaf with body and a light ripe mahogany leaf might be called the planter's ideals, and are unquestionably the two most profitable classes of leaf to grow; a crop with a high proportion of these grades is generally the product of a medium soil, and although the crop may only weigh 450 to 550 lb. per acre, it is always more profitable than a heavier crop of 600 lb. to 700 lb. of coarse rank tobacco, which, on curing, produces a high percentage of dark mahogany and low-class green leaf.

As the percentage of dark leaf rapidly increases with the nitrogen content of the soil, the practice of attempting to grow bright tobacco directly after green manuring on medium or heavier soils is justly unpopular. Crops of much better quality are produced on virgin and grass lands, and it is not unnatural therefore that planters in Nyasaland (where land is comparatively cheap) open up new land rather than maintain their tobacco lands in a high state of fertility by using green manures. Moreover, the rapid growth of weed soon kills out the green manure crop unless reasonably cultivated, and there being no possibility of profitably exporting low-valued legumes to meet the expense of cultivation and a general shortage of labour in the planting and growing season, local conditions largely nullify the profits of green manuring for tobacco.

Tobacco growing in Nyasaland is a good example of the exhaustive nature of annual as against perennial crops, and the world-wide application of extensive rather than intensive cultivation by European settlers in new countries.

It will be noticed that the writer has refrained from mentioning the use of artificial manures in this connection, but the omission may be explained by simply stating that the cost of artificials, on account of present transport conditions, is 200 per cent. greater than in England.

Cotton seed is sometimes used for manuring tobacco lands, but on the stronger lands it has to be used sparingly, as it has a tendency on such lands to increase the percentage of coarse tobacco and delay ripening.

Before leaving this question, it should be stated that continuous tobacco growing for a period of four years on the same soil is not advocated, but present local conditions frequently make such practice the most profitable, and, therefore, the one most generally followed, although a system of rotation with cotton has many advantages.

Nurseries and Transplanting.

The preparation of nurseries commences in early October, when a suitable site with a dark-coloured friable soil near a running stream is selected, levelled, trenched, and all roots and vegetation removed. Level beds are then made 3 ft. 6 in. wide and raised 6 in. above the general level; the surface soil is carefully prepared to produce a fine seed bed, and a few days before sowing the beds are covered with a layer of dry grass and small brushwood, and thoroughly burned to aid disintegration and sterilization of the soil.

After burning, the larger pieces of unburnt wood are removed and the fine wood ashes worked into the surface by hand or with an ordinary iron garden rake; the beds are then re-shaped and finally firmed down and sown. About 20 to 25 lineal yards of bed are allowed for each acre.

Tobacco seed is very small, and one heaped teaspoonful of good seed mixed with dry, fine wood ash and sand is sufficient to sow 70 square feet of bed. After sowing, a thin layer of grass is again spread over the beds and the whole thoroughly saturated with water, the seed bed receiving sufficient water to keep it moist but not wet, frequent light applications being preferable to heavy applications at long intervals.

The tobacco beds require daily attention, and immediately the seed begins to germinate weeds must be removed, and the covering grass fixed on supports a few inches above the beds.

As the seedlings grow the beds should receive diminishing shade by raising the grass cover until it is some 3 ft. above the ground, and, before planting out, the seedlings should be gradually hardened to stand the full effect of sunlight and heat.

There is great diversity of opinion as to the size the plants should be before planting out, but anything with leaves between 2 in. and 4 in. in length is quite suitable, the age varying from six to ten weeks.

In a country with a fluctuating local rainfall like Nyasaland, and especially with a crop requiring considerable harvesting accommodation, it is all-important to have nurseries and growing fields at various ages throughout the planting season, which normally extends from the end of November to the middle of February.

In the higher uplands of Blantyre (3,000 ft.) tobacco is planted from late November to the middle of January; later planting is not a success. In South-east Mlanje, however, at an elevation of 1,000 ft. to 1,500 ft. and with heavier rainfall, the most successful plantings are obtained in February and March. It is evident, therefore, that local conditions, ascertained by experiment, alone determine the planting season for any given locality, and in this respect tobacco is extremely particular.

Field Management.

Prior to planting out, the land is made into low ridges or small hills 3 ft. apart and the necessary surface drains cut.

Every opportunity is taken to replace as expeditiously as possible seedlings which do not take root or become destroyed by cut worms, and care should be exercised to avoid breaking the roots of the seedlings; this is best assured by saturating the nurseries prior to removing the young plants.

An ordinary planting requires at least 10 to 15 per cent. of supplies, and a day of bright sunshine immediately after transplanting may necessitate as high as 75 per cent. of supplies.

After the young plants are established they require frequent shallow hoeing, gradually working the soil to the base of the stem, and continual destruction of leaf caterpillars, stem-borers, etc. Until the crop is half-grown plants which show signs of "Frenching" must be replaced, whilst from the time the plants are half-grown until they reach full size, such operations as suckering, budding, and removal of ground leaves (priming) require daily attention.

The labour entailed in the cultivation of tobacco is at least double that needed for crops such as cotton or coffee, and where all work is done by the hoe, as on most Nyasaland estates, a permanent staff of labourers approximating two men per acre is required to cultivate thoroughly and harvest the crop.

The period for which the crop occupies the land largely depends on the rainfall, temperature, and cultivation, the earlier plantings of late November and first week of December maturing more rapidly than the later plantings of January and February.

Tobacco curing generally commences from the middle to the end of February, and continues to the middle of July; the average time from transplanting to beginning of harvest is twelve to fifteen weeks.

Harvesting.

The terminal bud should always be allowed to grow until it is clear of the small top leaves, but it must be broken off prior to opening into flower, leaving from ten to fourteen leaves to mature.

After topping, the leaves grow larger, provided the sucker buds in the leaf angles are regularly removed, and two or three weeks later the lower leaves begin to mottle and yellow, and as this ripening condition moves upwards, the leaves are removed singly by hand and conveyed to the curing barns in baskets.

Tobacco should never be harvested when the dew is on it, and great care must always be exercised to handle the leaf as carefully as possible, every injury diminishing the value of the finished product by increasing the percentage of scrap.

Curing.

In the first place, the acreage planted on any estate must not exceed the barn accommodation, and every season sees many acres actually lost, or the value of the leaf reduced by 50 per cent. through lack of foresight in this direction.

It is well to keep the barns fully occupied during the curing season, but it is madness to grow tobacco and leave it rotting in the fields through deficient barn accommodation, and a small acreage well cultivated and properly harvested is always more profitable than a larger acreage rushed through the curing barns, imperfectly cured and partially wasted in the fields.

Nyasaland planters as a whole are inclined to plant a larger acreage of tobacco than they can properly handle, especially as climatic conditions interfere with the normal ripening of their various plantings. Where the motive power is the African native, under the supervision of a single white man, 100 acres should be the maximum planted, and to ensure good curing six to seven large burnt-brick barns 20 ft. square and 22 ft. to the wall plate, with thickly thatched roofs, are required for every 100 acres cultivated, and if properly worked each barn is capable of producing four to five tons of cured tobacco in a season.

The capital outlay on barns, grading, and bulking sheds is considerable, each barn costing from £30 to £35 to erect, and the total expenditure on buildings to handle 100 acres of tobacco would not be over-estimated at £350.

Before proceeding to the actual process of curing, a word with regard to fuel will not be out of place, as the value of any estate for tobacco growing largely depends on the fuel supply for curing. Each barn of the dimensions already mentioned is capable of turning out at a single curing 1,200 lb. to 2,000 lb. of tobacco, depending on the quality and body or solidity of the leaf; the amount of fuel required for the production of this quantity of tobacco varies between 8 to 14 cubic yards, depending on the class, age, and size of the timber used. It is therefore obvious that re-afforestation must go hand-in-hand with tobacco cultivation if the industry is to be placed on a permanent footing.

As soon as the leaves are brought in from the fields they are fastened in pairs stem to stem on bamboos some 4 ft. in length, which are placed on the barn tiers 6 in. to 8 in. apart, according to the size of the leaf, commencing the barn filling from above downwards.

This work should be carried through as expeditiously as possible, the best results being obtained by filling each barn in a single day. Considerable care and judgment are necessary not to overload by placing the bamboos so close as to interfere with the free circulation of air and control of temperature.

The actual process of flue-curing consists of the following three distinct operations, viz.:—

(*a*) *Sweating the leaf to obtain the yellow colour and fixing same.*

(*b*) *Drying the leaf.*

(*c*) *Drying the stem and sterilizing the tobacco.*

(*a*) *Sweating the leaf to obtain the yellow colour and fixing same.*—It is impossible to set down any fixed temperatures for curing tobacco, as the raising of the temperature for stages (*b*) and (*c*) largely depends on the behaviour of the leaf in stage (*a*). Some tobacco sweats freely and turns yellow twelve to thirty hours after it is placed in the barns and subjected to temperatures between 85° and 90° F., whilst other tobacco refuses to sweat and remains green until water is spread on the barn floor and the temperature is kept at 100° to 105° F. for ten to fifteen hours, when the desired colour may appear. It is a good sign when tobacco becomes yellow early in the first stage of curing, and it is important to see that the leaf blade is uniformly yellow to the mid-rib before raising the temperature above 110° F., when drying sets in, as once the leaf becomes dry it is dead, and the colour cannot then be altered by subsequent manipulation of temperature and ventilation of the barn.

Green-cured leaf can be improved to a certain extent by bulking, but it never produces such high-class tobacco as when the colour comes naturally in the first stage of curing, and for this reason it is important to see that once the desired colour is obtained it is fixed, and this is accomplished by raising the temperature in four to eight hours from 110° to 120° F.

The range of temperature to complete the yellowing of the leaf may be anything between 90° and 110° F., and 110° to 120° F. fixes the leaf colour. This first stage may occupy on an average two and a half days.

(*b*) *Drying the leaf.*—Now that the tobacco is of the desired colour, the aim is to stop leaf-sweat and dry out the leaf by raising the temperature slowly by 5° at a time from 120° to 135° F. The duration of this stage is from twenty-eight to thirty-six hours, but considerable manipulation of ventilators and heat is necessary to prevent leaf splotch.

(*c*) *Drying the stems and sterilizing the tobacco.*—

The temperature is now raised to 140° F. and maintained at this level for five hours, when it is raised in a further period of three to four hours to 145° F., when the tobacco should appear dry and curled at the tips.

In order to dry the stems thoroughly and sterilize the tobacco the temperature is further rapidly advanced to 170° F., and kept at that temperature for from ten to twenty hours until the whole leaf, including the stalk, is dry and brittle; when curing is finished the fires are drawn, and as the temperature falls to 120° F. doors and ventilators are thrown open, and the tobacco left until it has absorbed sufficient moisture to enable it to be handled without breaking.

Before leaving curing one word is necessary, viz., to see that mats are always in position half-way between the lowest tier and the flues, as any dry leaf falling on the red-hot iron flues will set the whole barn in flames. Several barns are destroyed every year for lack of this simple precaution.

Bulking.

If the weather is exceptionally dry the conditioning of the tobacco can be hastened by sprinkling water on the floor when the inside temperature has cooled down to below 120° F., but under ordinary conditions this is seldom necessary.

The barn is then emptied from below upwards, the tobacco removed from the bamboos, and each curing bulked separately, butts outwards, but never left loosely exposed to the air.

The bulks require a little attention to see that they do not become mildewed or heated, and in a few days they may be graded, and the leaves tied into hands and re-bulked or sold to the local factory.

In conclusion, the writer would state that the main obstacle to the further extension of the tobacco industry in Nyasaland is the difficulty planters are experiencing in obtaining a quick market at remunerative prices for our rapidly increasing tobacco crop. The length of time it takes brokers to realize the crop on the home market and the heavy charges for storage and cash advances to carry on in Nyasaland forces a large percentage of our smaller planters to sell locally for cash at lower prices than can be realized on the home market.

The home tobacco market is a difficult one for a new country to get a footing in, and although the writer is proud to state that Nyasaland tobacco is the only serious and successful competitor that has ever competed with American-grown "bright" tobacco, yet he fully realizes that many obstacles have to be overcome before our new industry is on an equal footing with the long-established tobacco industry of America, and our watchword for the present should be "steady progress, based on sound quality rather than excessive tonnage," increasing our output as our product becomes appreciated by the British public, and on no account overstocking the market before it can be absorbed.

We have the patronage of the Imperial Tobacco Company for the larger part of our present crop, and what is good enough for a company with their experience should rapidly become good enough for other manufacturers, who no doubt will give the tobacco a fair trial, now that the production is beyond the experimental stage and showing signs of permanent establishment.

THE CULTIVATION AND FERTILIZATION OF TOBACCO IN THE UNITED STATES.

By William S. Myers, D.Sc., New York.

The medicinal properties and modes of preparation of tobacco have been the subjects of many authors, and this "queen of plants" has, within a few hundred years, risen to the position of a wonderful article of commerce and a source of great fortunes, as well as a source of pleasure to thousands of people. The North American Indians, who first used it, called the plant "Uppowoc." They were said by the earlier Spanish writers to have smoked themselves into insensibility, and apparently the Indians obtained more violent and peculiar effects than Europeans usually find from its use.

John Rolfe, who married Princess Pocahontas, was the pioneer English tobacco planter of Virginia, and it is stated that he began to grow the plant about the year 1606 in the "Old Dominion," but in 1639 the Grand Assembly of Virginia passed a law restricting the amount of tobacco which might be grown in the Commonwealth. In the early days of the Colony tobacco was frequently used as legal currency. From that time onwards the cultivation of tobacco spread throughout the world, and soon the use of snuff and other modes of consuming it became almost universal.

Areas of Production.

The principal areas of tobacco production in the United States are in Kentucky, North Carolina, Virginia, Ohio, Tennessee, Wisconsin, Pennsylvania, Connecticut, South Carolina, Indiana, Maryland, West Virginia, and Massachusetts.

Character of Lands.

In Virginia planters formerly did not plant tobacco on old lands, and kept moving their tobacco field to new soils. A dark-coloured loam was selected for dark tobacco, and if a light-coloured wrapper were desired, a light loam was selected. In Connecticut a light, moist loam was most desired, and in Maryland a light, pliable, sandy loam was generally selected.

Tobacco in many districts of Virginia, North Carolina and South Carolina is planted on a sandy or sandy loam soil, with a yellow or red clay subsoil. Where a bright yellow tobacco is specially desired, the yellow clay subsoil is preferred.

Preparation and Fertilizing of the Seed Bed.

The time of preparing the tobacco seed bed varies from February, in South Carolina, to April, in New England. Without doubt, every step in the preparation of the soil is of importance. The seed ground should be well sheltered, weed seeds should be avoided, and the more level the ground the better. When the soil is prepared in drying weather it should be done quickly to prevent its setting like cement. Overworking is bad, for it frequently reduces some soils to a paste into which the roots of the tobacco plants penetrate only with difficulty. However, the soil must be well drained and worked to a fine tilth to a good depth. The plants should not be subjected to too much watering, especially in the earlier stages, for its evaporation would chill the ground too rapidly.

It was frequently customary in the early days to burn off a piece of forest land for a seed bed. The sterilization of the ground by heating aided in promoting a healthy growth, but this practice has been almost completely abandoned.

A pint of corn meal and a pint of land plaster for each square rod were formerly used to advantage to help start the plants. If the bed is not too broad, the necessary weeding can be done by hand without damaging the plants. Generally 5,000 to 6,000 plants per acre are sufficient, and these may be grown on a seed bed of 22½ square yards. In order to save time, growers occasionally sprout the seed rapidly prior to planting, by spreading the seed thinly on a cotton cloth, and rolling it up inside a woollen cloth, then dipping in warm water every day and keeping in a warm place.

Nitrate of soda is now used almost everywhere in our tobacco belt in the fertilization of tobacco seed beds, it being ploughed or worked into the soil at the time of sowing at the rate of 2 lb. to 20 square yards, which is equal to 200 lb. per acre. The result is almost invariably to produce fine plants for setting out.

An interesting feature of late in the fertilization of tobacco has been the application of a solution of nitrate of soda to the early seed bed, the latter being covered by cheese-cloth for the purpose of keeping off frost and protecting it from a very hot sun. The North Carolina planter who tried the experiment poured a comparatively strong solution of nitrate—1 lb. of nitrate to 3 gallons of water (some use only one tablespoonful of nitrate to the gallon)—on the cheese-cloth and allowed the solution to drip on the seed bed. Of course, this method allowed the cheese-cloth to absorb a certain amount of the nitrate from the solution and doubtless weakened it.

The possibility is here suggested of new investigations along the line of applying nitrate of soda in solution, since it has been so successful on deciduous fruit trees, and at least it may be well worth trying on some of the more tender crops, but in very weak solutions.

Transplanting.

In the old belt, which includes the Piedmont section of North Carolina and a few of the Middle Southern Counties of Virginia, tobacco is transplanted in 3½ ft. to 4 ft. rows, 2½ ft. to 3½ ft. in the drill, from the first of May to the first of June. In the new belt, which includes Eastern North Carolina and all the tobacco district of South Carolina, tobacco is transplanted in 3½ ft. to 4 ft. rows, the same as in the old belt, but it is planted thicker, most of it from about 2 ft. to 2½ ft. apart in the drill.

The tobacco plant requires careful transplanting and the unremitting attention of the planter afterwards. It has thick, fleshy roots, scantily furnished with root hairs, and its foraging powers for food and water are small compared with ordinary field crops. Hence, comparatively shallow but continuous and thorough cultivation, and readily available forms of plant food are needed.

Tobacco plants are transplanted when four or five leaves have appeared and this is sometimes done by a machine called the "Bemis transplanter," which has been well spoken of by many growers.

It is better not to set out too large plants, since the tendency will be to make the subsequent growth too stocky. This is an important point, since it is frequently inferred that over-cultivation or over-fertilization makes too stocky a plant growth.

Cultivation.

Since tobacco plants grow and ripen in a few weeks from the time of transplanting, it is very important that they get a good start. Under ordinary cultivation plants will be ready to harvest from eight to ten weeks after setting out.

Cultivation should begin soon after transplanting, as otherwise the plants are certain to become stunted and dwarfed, and should be kept up every week or ten days until the plants have grown large enough to be topped. Thorough cultivation as well as proper fertilization will nearly always bring stunted plants forward.

Variations in cultivation are just as responsible for falling off in quality, and even more so, as unintelligent fertilization.

Fertilizing.

Plants need the proper kind of fertilizing at the right time, and fertilizers are especially effective if the ground be cultivated after applying them, or if a rain follow the application.

The texture of the leaf and burning quality of tobacco are frequently injured by certain coarse animal forms of nitrogenous fertilizers, and the presence of chlorine in fertilizers is to be avoided. Objections have been raised against such coarse animal matters as slaughter-house waste, coarse meat scraps, and the like.

In humid weather very active fermentation and putrefaction will sometimes accompany the nitration of the coarser forms of nitrogen, and hence the desirability of having a nitrogenous fertilizer which is under perfect control. Many materials are in a coarse condition and cannot be properly used.

Tobacco is a very strong feeder and requires heavy fertilization. The most important of all fertilizers for tobacco is nitrogen, and the choice and management of this particular fertilizer frequently will determine, more than any other single factor, the final quality of the leaf.

Success, the art of taking pains, always means doing things the *best* way. We know that tobacco needs a steady supply of available nitrogen. Nitrate of soda will supply this, but many other forms of plant food nitrogen will not, except indirectly and with irregularity.

Unquestioned authorities in experimental agriculture have shown that 1 lb. of nitrogen in various forms has also a varying power of ability to make vegetable growth. On the basis of scientific plant feeding, it takes, for example, 312 lb. of barnyard manure nitrogen, or 185 lb. of coarse tankage nitrogen, or 149 lb. of nitrogen of cotton-seed meal, or 145 lb. of nitrogen of dried blood, or 114 lb. of sulphate of ammonia nitrogen, to equal 100 lb. of nitrate of soda nitrogen. These figures have been substantially confirmed by different leading experiment authorities in North America and Europe.

Chilean nitrate is the form in which plants make the best use of nitrogen. None of the other commercial fertilizer materials in America holds its nitrogen in this form. The other nitrogens, however, are converted into the nitrate form in the soil, through the action of certain soil micro-organisms. Now there are certain soil and weather conditions favourable to this change of form, others distinctly unfavourable, and conditions under which soil organisms cause the actual loss of nitrogen. It is evident, therefore, that in Nature's making nitrate from non-nitrate nitrogenous materials there are certain losses of this valuable element, hence the different efficiency values of the various nitrogen fertilizer materials above quoted.

The mere loss of a certain amount of nitrogen does not represent all the evil. In the use of various low-grade nitrogen fertilizers the speed with which the nitrogen is made available depends almost entirely upon weather conditions. At times, therefore, the supply of nitrate nitrogen may be ample, but at other times it may be almost absent, hence the plant food is supplied irregularly and plant growth is accordingly irregular. While with some crops this means no more than a short crop, with tobacco it may mean not only a short crop, but also a low grade of thickened leaf or too heavy ribs and veins.

Whilst nitrate of soda is the most efficient form of nitrogenous fertilizer for tobacco, it must be used with intelligence and care, just as high-powered locomotives and all highly efficient things in the world require intelligent brains to handle them.

Frequently special fertilizers are used for tobacco, and in our Connecticut Valley all kinds of domestic and commercial fertilizers are used. Peruvian guano, when it could be secured pure, was doubtless one of the best, since it imparted a remarkable fineness and colour to the leaf. Saltpetre waste and ground bone have given good results. All the natural or humus-carrying manures should be thoroughly covered over, but it should be remembered, however, that they provide only incomplete plant food.

Linseed and cotton-seed meals are in such demand for feeding cattle that it is getting more and more difficult each season for tobacco planters to secure such materials in quantity. Dried fish, being a coarse source of nitrogen, is less used, being open to objection as above indicated.

On a very poor, sandy soil near Blackstone, Virginia, where minimum crops of all kinds had been grown for years, an experiment was carried on in growing tobacco on two plots of one acre each. On the "no nitrate" plot only 225 lb. of low-grade tobacco were produced; on the other 100 lb. of nitrate only were used, and a crop of 425 lb. of fine quality leaf tobacco was produced.

The Kentucky Experiment Station, when experimenting with one unfertilized acre of Burley tobacco, secured a product valued at $67.20. On another acre 160 lb. of nitrate of soda alone was used, and the tobacco crop increased in value to $138.40, largely consequent upon improved quality of the crop. On another acre fertilized with an application of 160 lb. nitrate of soda, 320 lb. acid phosphate, and 160 lb. sulphate of potash, the value of the crop was increased to $201.30.

The fertilizer for tobacco recommended by that station is an application per acre of:—

Nitrate of soda	300 lb.
Sulphate of potash	200 ,,
Acid phosphate (16 per cent.) ...	100 ,,

One-third, viz., 100 lb., of the nitrate of soda is to be mixed with the potash and phosphate and applied between the rows, and then thoroughly cultivated into the soil just before setting out the plants.

As soon as the young plants are thoroughly established and just in advance of the first hoeing, a second 100 lb. of nitrate of soda alone should be applied per acre, distributed along the rows.

The third application of nitrate, viz., 100 lb., should follow about three weeks after the second, and should be applied in the same manner. Accurate and timely application of nitrate of soda is the secret to tobacco success, and careless growers had better not use fertilizers at all.

A crop producing 1,000 lb. of dried leaf per acre will actually require 67 lb. of nitrogen and 85 lb. of potash. It is not reasonable to expect every pound of the plant food to reappear in the crop, for this particular crop, as above stated, has but a narrow range of foraging power as to soil plant food. Therefore, the application above recommended by the Kentucky Experiment

Station is not regarded as too heavy for Kentucky conditions, and is well within the bounds of "taking pains." The above mixture may be applied in the drill, or half in the drill and half broadcast, and the land ridged up, before the tobacco is transplanted.

According to the United States Bureau of Plant Industry, from 800 to 1,000 lb. of a complete fertilizer per acre should contain from 3 to 4 per cent. nitrogen, 6 to 10 per cent. potash (always as sulphate), and 8 per cent. phosphoric acid.

In North Carolina a fertilizer is used on the field at the time of transplanting containing 3 per cent. nitrogen, 8 per cent. phosphoric acid, and 3 per cent. potash. This fertilizer contains nearly one-third of its nitrogen in the form of nitrate of soda, that is to say, about 125 lb. in each ton of the mixture is Chilean nitrate. This is also the practice now recommended by the United States Bureau of Plant Industry for the North Carolina tobacco-growing areas. The balance of the nitrogen is in the organic form and of the highest grade organic material in a very fine state of division.

One grower in North Carolina used nitrate at the rate of 100 lb. to the acre alone, and sold his crop at 17 cents a pound, and where he used no nitrate he was obliged to sell the crop for 9 cents a pound.

Chilean nitrate is also used in North Carolina as a side dressing and followed by cultivation about June 15, when the crop is half-grown. It makes more weight and does not make the fibre heavier. The average yield of tobacco in North Carolina is 670 lb. to the acre. The soils, however, are, as a rule, rather light and low in fertility.

When nitrate is applied in solution, ½ oz. is dissolved in a gallon of water, for the double purpose of watering and feeding the tobacco plants. Nitrate solution may be applied at the rate of about half a gallon of water to each tobacco plant subsequent to transplanting. This would amount to a little less than an application of 100 lb. per acre.

The use of commercial fertilizers, generally speaking, improves the quality of the tobacco. They give the plant an early start, mature it earlier, make a better manufacturing tobacco, and also increase the yield. It is possible that extremely weak solutions of nitrate, say a quarter of an ounce to a gallon, would be most effective.

Although the skilful use of available nitrogen is the key to financial success in tobacco growing, many large growers moderately successful have no idea of the quality or nature of the nitrogenous fertilizers which they are using when they use mere brands of ready mixed goods.

Certain American tobacco growers who are most given to criticizing nitrate fertilizers have been found upon investigation to be wholly unacquainted with the composition of the particular fertilizers they happened to be using, and had no idea whether such fertilizers contained nitrate of soda or not. In a fertilizer, containing 2½ per cent. nitrogen, 8 per cent. phosphoric acid, and 3 per cent. potash, in use this very season on tobacco in North Carolina by growers condemning the use of nitrate, a trifle less than one-quarter of its nitrogen was found to be nitrate of soda, and this was sold to tobacco growers for the avowed purpose of avoiding the use of nitrate.

Nowhere in agriculture does accurate knowledge repay its possessor more abundantly than in tobacco growing.

Since conditions vary in different countries, no attempt is made here to suggest specific formulas for tropical countries. It is believed that Chilean nitrate, however, is worthy of a place in any fertilizer formula for tobacco.

The total tobacco area in the United States is 1,294,911 acres and the production is 1,055,764,806 lb., making the average yield 815 lb. per acre for the whole country, whilst Germany, with about 38,975 acres in tobacco, has a total production of 62,933,016 lb., making an average yield of 1,615 lb. per acre. This difference is due substantially to the well-known higher content of available nitrogen in all German commercial fertilizers and also the more rational and intelligent use of the higher-powered nitrated German fertilizers. It would be well for our American planters to imitate their German brethren in this respect.

Topping and Suckering.

Topping is done to prevent the plant from going to flower and seed. The leaves ripen sooner if the plant be topped. Some growers top the plants as soon as the buds appear, while others wait until full blossom. From nine to twelve leaves should be left on each plant if leaves of nearly uniform size are desired. Some growers top the plant by pinching the leading stem, which will prevent the formation of buds or flowers.

Whenever shoots or suckers appear at the base of the leaves where they join the parent stalk, they should be removed. If they are allowed to grow longer than 2 or 3 inches there will be a tendency to the production of a thin, poor leaf.

Harvesting.

From three to five weeks after tobacco has been topped it should begin to ripen, and just as fast as it ripens it should be harvested. The wise grower should fertilize carefully but heavily, thus insuring a good tonnage, and by good attention secure big yields of prize quality. The stalk is either split and hung on a stick or the leaves are stripped off the stalk, tied up in bundles and hung up in the curing barn. In districts where tobacco is primed or stripped off the stalk, harvesting can begin very soon after topping; in fact, farmers sometimes begin priming off the bottom leaves the same week they begin topping, but in the old belt harvesting has to be postponed until most of the leaves are ripe. Frequently bottom leaves are lost in the field, however, through waiting for the top leaves to ripen.

Much practice is necessary to determine the precise time for cutting the tobacco plant, and personal experience of the grower is important in this respect.

Curing.

It takes about four days and nights continuous firing to flue-cure a barn of tobacco. The temperature varies from 95° up to 200° F. at the finish.

Steam curing is now coming rapidly into use and is giving the greatest satisfaction.

Perhaps no other field crop is so dependent upon quality for its market value. Export tobacco may be permitted a somewhat rank growth, but the maturing must be thorough, for the curing of the crop promptly reveals growth defects. Wrapper tobacco, and the higher grades generally, distinctly show the effects of careful attention to crop needs.

Pests.

There are two kinds of worms that are very troublesome to tobacco, namely, the cut worm and the horn worm. The latter feeds upon the finest and largest leaves. In Virginia and North Carolina a flock of turkeys put in the field generally devours these pests promptly.

THE CULTIVATION OF TOBACCO IN THE VORSTENLANDEN OF JAVA.

By Dr. H. Jensen.

The area under tobacco in the Vorstenlanden is small; in the year 1913 it amounted to only about 10,000 hectares. As the estates only grow tobacco annually on two-fifths of their grounds—on the remaining three-fifths rice or other native crops are cultivated—the total area of the tobacco estates in the Vorstenlanden amounts to about 25,000 hectares, or rather less than the area covered by London.

In the course of the five years 1907-1911 the exports from the Vorstenlanden to Europe amounted to:—

In 1907 ...	9,285,040	kilograms	of a value of	10,213,544	florins
In 1908 ...	9,255,120	,,	,,	9,023,742	,,
In 1909 ...	8,406,000	,,	,,	8,321,940	,,
In 1910 ...	7,643,760	,,	,,	7,643,760	,,
In 1911 ...	13,125,680	,,	,,	12,600,652	,,
	47,715,600	,,	,,	47,803,638	,,

This large yield was obtained, as mentioned above, from an area of about 10,000 hectares, or about 1,000 kilograms per hectare annually. The yields from the different estates vary. The largest average yield of one estate during the above quinquennial period was 1,655 kilograms per hectare. The smallest yield of another estate, being the average of the same quinquennial period, was 583 kilograms per hectare. A single estate once produced about 2,800 kilograms per hectare, a truly enormous production compared with other tobacco-producing countries.

These high crop figures are still more striking when it is considered that such a crop is taken out of the ground every two years, and very different from Deli (Sumatra), which produces the finest wrapper leaf of the whole world. There tobacco is only cultivated on the same ground every seven or eight to ten years, and yet the yield there is considerably less than in the Vorstenlanden.

How, then, is it possible for the Vorstenlanden planter to obtain such large crops from his land? It is not by the use of enormous quantities of manure, for many estates, including the best and most productive, use no artificial manures at all, and stable manure is rarely used. As a matter of fact, the number of cattle kept on the estates is seldom very great. On one estate of about 1,200 hectares, which is one of the richest in cattle, there are only about 250 kerbouws and 750 sapies, or together, about 1,000 head of cattle. Further, only a small portion of the dung is preserved as manure, as the people have no actual stables. This is also evident from a consideration of the figures showing the quantity of so-called stable manure purchased by the estates from the natives. The percentage of nitrogen this contains varies enormously. Very good manure may contain up to 1·29 per cent. of nitrogen, but this is exceptional, most of it only containing about 0·5 per cent. and often not above 0·2 per cent.; one sample only showed 0·06 per cent. of nitrogen.

The principal cause of the exceptional yields is to be found in the method of cultivation, viz., the growing of tobacco and rice alternately. The rice crop does not exhaust the soil; but, on the contrary, through the wet sawah cultivation the land is undoubtedly immensely improved, in spite of the fact that large crops of rice are taken out of the ground. On good estates in the Vorstenlanden, each rice crop may be relied on to produce on an average about 3,500 kilograms per hectare. On very good land the yield in the rainy season may be much in excess of this figure, and may even be as much as 5,500 kilograms per hectare.

These enormous crops are not obtained just once a year. On a certain piece of ground the planting during a period of two years consists of: once tobacco, and three times rice, about five months being taken up by the very intensive preparation of the soil which precedes the cultivation of tobacco. Of an actual "break," during which the soil is resting, as is usual in Europe, there is no question here. The division according to the seasons is as follows:—

January-May: Sawah (wet rice fields).
June-October: Sawah (wet rice fields).
November-March: Sawah (wet rice fields).
April-July: Preparation of the soil.
August-December: Tobacco.

The real cause of the favourable influence on the fertility of the soil of the wet rice cultivation (sawahs) has never been quite clear. It is true that the water conveys large quantities of plant food to the rice fields in the slime which it carries with it, and much more is dissolved in the water itself; but, on the other hand, the water, running from one estate to the other before it finally reaches the sea, also carries off large quantities of plant food from the sawahs, which leaves the balance rather in doubt. Of greater importance probably is the fact that through the water remaining stagnant on the sawahs it gets heated to such an extent by the tropical sun that the processes of dissolution in the soil are thereby much accelerated. And, finally, it is far from imaginary that the biological processes in the soil may be favourably affected by the supply of water. Whatever may be the cause of the favourable influence on the soil of the wet sawah cultivation, without it the enormously intensive use of the land in the Vorstenlanden would be impossible. Now the Vorstenlanden have from the remotest Hindoo times been subjected to intensive cultivation, and the Javanese coolie from the Vorstenlanden, having from one generation to another worked with wet sawahs, has become naturally a born waterworks engineer. The irrigation works established by the natives are indeed admirable, but they are, of course, capable of enormous improvement and more rational construction at the hands of European technical engineers. In this respect the tobacco cultivation in the Vorstenlanden has of late years made enormous progress. As an illustration we may mention the magnificent "van der Wyck aqueduct," which has a water capacity of 300 cubic metres per minute and a length of 6½ kilometres, and which is capable of irrigating more than 1,500 hectares.

So many questions are bound up with the actual cultivation of the tobacco plant from beginning to end, from the collection of the seed to the gathering of the leaf, the drying of the picked leaf, the fermenting, the sorting, etc., that it is easily understood that tobacco planters have felt the necessity of establishing a testing station. As a consequence, a "Testing Station for Vorstenlanden tobacco" was established at Klaten on a fairly extensive basis—in 1913 it was estimated to cost 75,000 florins—and to which nearly all the tobacco estates in the Vorstenlanden are affiliated. The testing station is closely connected with the Department of Agriculture at Buitenzorg, whose director has the power of appointment and dismissal of the scientific staff of the testing station and has a casting vote in the arrangements concerning the working programme, etc. The testing station is not an analytical control depot, but its object is to examine all doubtful questions touching tobacco cultivation in the Vorstenlanden by making careful tests, and by rendering the results thereof and of experiments made elsewhere of practical use in tobacco cultivation. Quite naturally, therefore, the work of the testing station is illustrative of the changes and improvements which have taken place in the cultivation itself, although, of course, only part of the researches of the testing station have resulted in such improvements.

Amongst the improvements in cultivation introduced during late years the very deep tilling of the soil practised at the present time is of enormous significance. Through the persistence of the very energetic planters in the Vorstenlanden such intensive tilling is now applied as is not exceeded in any part of the world. By means of the "Patjoel" the soil is turned to a depth of 18 in., a tilling fully equal to the intensive tilling of a kitchen garden of a European villa, and it must not be overlooked that we are dealing here with large estates, often of more than 400 hectares, planted with tobacco. This, of course, is only possible where there is a large population, and it is calculated that at least 400 coolies are required for every 100 hectares, at all events on the good estates. Different systems of deep tillage have been invented and applied by the planters. Strict tests to ascertain the several advantages and disadvantages thereof have been initiated by the testing station.

Closely connected with the tilling of the soil is the manuring of the gardens. This is generally done with stable manure purchased from the natives. The value thereof varies immensely, as already mentioned. It may be assumed that this purchased " stable manure " has at least as great a fertilizing effect on the soil by the introduction of bacteria as by the amount of nitrogen it contains, which is often very low. Artificial manure was never employed formerly. It was feared that by its use the tobacco leaf would suffer as regards fineness and colour.

Very extensive manurial trials carried out by the testing station have shown that very many of the estates possess such good soil that artificial manure would be quite superfluous there. On other estates, on the contrary, an important increase in production is obtained by the introduction of artificial manure, which increase fully makes up for the extra cost involved. It is very remarkable that this influence of artificial manure only affects nitrogen, and perhaps on a few estates also phosphoric acid, but on not a single tobacco estate in the Vorstenlanden potassium, a fact which is, of course, closely connected with the formation of the soils which all have their origin in the crater of the great volcano Merapi. It is also a noticeable fact, which is confirmed by the many experiments giving perfectly similar results, that the quality and colour of the leaf do not deteriorate by the addition of artificial manures, such, for example, as sulphate of ammonia, of which Europe is afraid. In some cases, indeed, an improvement was shown through the use of artificial manure.

As regards harvesting, the so-called " tree gathering " was the universal custom in former times. The entire tobacco plant was cut down, and with the leaves on it suspended in the hanging sheds to dry. Later on all tobacco estates in the Vorstenlanden resorted to " leaf gathering, *i.e.*, each leaf is gathered separately from below upwards according to its ripeness. The leaves are subsequently strung on thin bamboo sticks and suspended in the drying sheds until they are sufficiently dry. Here they assume a brown colour, which is of great importance to the value of the tobacco after fermentation. Of late years the testing station has started to examine the conditions which influence the colouring of the leaf. Such researches are necessary in order to work out an efficient method of picking and drying, tending to promote the development of certain desirable qualities and to guard against undesirable ones. Unfortunately, such researches are very difficult, and the results so far have been insignificant. Various indications have, however, been obtained showing in what direction this work should be conducted.

Of very great importance, especially as regards the top-leaf, is the change which of late years has been made in "topping." Formerly it was customary to top very strongly; now hardly any topping is done, and on many estates it has quite ceased. This gives a somewhat smaller, but at the same time much thinner, top-leaf.

Fermentation is conducted quite as primitively as drying. Experiments have therefore been started with a view to guiding fermentation along fixed and desirable channels. The object aimed at is to devise a process in which it will be possible to regulate thoroughly the rate of increase in temperature, the degree of moisture in the piles, and the quantity of oxygen, and in which the piles are so arranged that they can be submitted to preliminary artificial heating without having to resort to re-piling, which absorbs a lot of time and money, and so that it will be possible to exercise a certain influence over the appearance of the fermented tobacco leaf.

It has been shown with absolute certainty that the fermentation of tobacco may be effected independently of micro-organisms, from which it naturally follows that the search for the bacteria which bring about first-class fermentation has been eliminated from the programme of experiments.

One of the greatest improvements of late years in the cultivation of tobacco in the Vorstenlanden is the introduction of "pure strains." The tobacco testing station started these selection trials in 1901, and the first selected seed of a pure strain was supplied to the estates in 1904. At the present time all estates, with the exception of two, employ seed of selected pure strains. On all seed plants the corollas are surrounded by klamboe bags to prevent pollen entering from outside, so that nearly all plantations in the Vorstenlanden are derived from self-fertilized seed. If at first some planters were afraid of "degeneration" through continued self-fertilization, they never refer to it now, and the estates now provide all their seed plants with klamboe bags. One result of the cultivation of pure strains is that any sound plant in the plantation may be selected as a seed plant, so that one may often see a collection of many hundreds of seed plants close together with the peculiar and very striking white klamboe bags, whilst formerly a selection had to be made from seed plants spread over the whole of the estate.

As the testing station, in making a selection, had to observe the wishes of the planters with regard to the requirements of a good strain, the result has been that nearly the whole of the Vorstenlanden now only use two strains, which are of almost identical type. This has caused the European market to complain of late years of too much homogeneity in the Vorstenlanden tobacco brands. This is truly a great triumph for the selection method, and happily it is an evil which can very easily be remedied by isolating new strains possessing different properties. This work has already commenced, so that the ideal of the testing station will probably be realized within a few years, viz., that each estate shall cultivate a pure strain of its own, suitable as to soil, elevation, etc., which will again supply the European market with different varieties of Vorstenland tobacco.

The tobacco plant is very susceptible to various diseases. In the Vorstenlanden two of these are of the utmost significance, the "Lanas disease," caused by *Phytophthora nicotianæ*, and the "Mosaic disease," the cause of which is a matter of dispute. The first of these two diseases exercises its injurious influence on the yield, and the second on the quality of the tobacco. To combat these two diseases is a very difficult matter, and so far all efforts to conquer them have failed. Yet it is tolerably certain that to neglect these diseases might lead to far greater injury than the loss which is now known. It is not impossible that the great susceptibility to these diseases has some connection with the intensive cultivation and with the selected and, in other respects, so valuable strains. Should this be the case, it may, of course, be hoped that other strains may be discovered which are better able to withstand these diseases; but it should not be overlooked that nothing is gained thereby if the new strains should produce a tobacco inferior to the present one. It is preferable to have a pure strain producing a fine leaf and susceptible to disease than a strain free from disease but giving a bad leaf. Provisionally, we shall have to regard the susceptibility to both these diseases as a necessary evil, to be fought with every means at our disposal.

On most of the estates a great deal of labour and money is being devoted to this struggle, and this principally against the Phytophthora, as they are really quite helpless against the mosaic disease. None of the many remedies suggested against the latter has met with any success. It seems that only by the exclusive use of healthy and strong seedlings, and by giving careful attention to the selection of seed plants to prevent any mosaic diseased trees being used for this purpose, the disease may be kept to some extent within bounds. Against the Phytophthora very many remedies exist, but none of them is efficient. Yet each of these methods has its special object. By means of various chemicals (lime and sulphate of ammonia, permanganate of potash, carbon disulphide, paraformaldehyde) efforts are made to disinfect the ground where the diseased plants stood, so as to preserve the life of the young plants which are to grow on the same spot, and to prevent traces of the disease finding their way to neighbouring plants. In the nurseries the disease, locally called "bibit disease," can with absolute certainty be kept within limits by watering with bouillie bordelaise. If only certain plants in the gardens are affected, the neighbouring plants may be protected from infection by applying caterpillar glue to the necks of the roots and by syringing with bouillie bordelaise. Of great importance, finally, is the destruction of the old tobacco stalks. Where formerly these stalks were cut up and ploughed into the ground to serve as vegetable manure—and at the same time as an infallible means of infecting the next crop—now all tobacco stalks are removed from the gardens, and on very many estates, although, unfortunately, not on all, they are burnt, either in piles in the open air, or, what is still better, in large furnaces specially constructed for the purpose. For the burning of dead young plants smaller iron furnaces are used which can be conveniently moved from one garden to another. How much has been accomplished in course of time by the adoption of these means of combating disease it is difficult to say, but it is tolerably certain that if nothing had been done the damage suffered would be much greater than is the case at the present time, where, at all events, the disease on most of the estates may be limited to a few known gardens.

To recapitulate the above, the following may be mentioned as the most important changes which have taken place in the cultivation of tobacco in the Vorstenlanden during recent years: —

(1) A very intensive tilling of the soil.
(2) A rational use of fertilizers.
(3) The abolition of topping.
(4) The adoption of leaf gathering.
(5) The introduction of selected pure strains.
(6) Intensive efforts to combat the Phytophthora disease.

The most important items on the programme for future improvements are: —

(1) A rational system of gathering.
(2) A rational system of drying.
(3) A rational system of fermentation.
(4) The introduction of pure new strains and crosses.

If the above appear to be very difficult points for research, so difficult even that many will doubt the possibility of a satisfactory solution, yet assuredly the energy of the Vorstenlanden tobacco planter, aided by the knowledge and insight of the staff of the testing station, will succeed at all events in making important progress towards a settlement of these difficult questions.

A SHORT SURVEY OF THE WORK OF THE TOBACCO-TESTING STATION IN DELI.

By Dr. L. P. de Bussy.

Director of the Deli Testing Station.

The Deli Testing Station at Medan has been established for the scientific study of all problems arising out of the cultivation of tobacco on the East Coast of Sumatra. It is proposed in the present paper to deal chiefly with the work of this institute during the last few years.

It was established in 1893, and is maintained by the tobacco companies of the East Coast. All the latter, thirty-two in number, with altogether ninety-five undertakings, are now affiliated to the Station. They annually contribute a sum of 150,000 fl. In 1913 a new laboratory was opened, in which the formerly separated departments have been brought together; the building expenses thereof amounted to 60,000 fl. The scientific staff consists of eight persons: Director, Dr. L. P. de Bussy; Agriculturist, Dr. K. Diem; Botanist, Dr. J. A. Honing; Chemist, Dr. S. Tymstra; Zoological Assistant, Dr. P. A. Dietz; Agricultural Assistant, A. N. J. Beets; Botanical Assistant, J. Vriend; Chemical Assistant, Dr. E. W. Remmert. There are, besides, a book-keeper and a native staff of about fifty men.

The results obtained were formerly published in the organs of the Government Botanical Gardens at Buitenzorg; since 1906 in the Chronicles of the Deli Testing Station, of which the annual issues I-VII have appeared, and VIII is now current; and since 1914, as regards purely scientific articles, in the Bulletin of the Deli Testing Station.

Before proceeding to a short survey of the work done in connection with tobacco proper, it may here be mentioned that the Deli Testing Station, as a subsidiary meteorological station of the observatory at Weltevredes, collects, and causes to be collected, meteorological particulars regarding:—

(1) The rainfall.
(2) The temperature.
(3) The relative moisture.
(4) The sunshine.
(5) The evaporation.
(6) The atmospheric pressure.

The rainfall data are obtained from 350 rain stations spread over the cultivated region of the East Coast of Sumatra, which forward their figures monthly to the Testing Station, to be published by it annually in the Chronicles. Of a large number of these stations, the elevation above sea-level, the distance from the coast, and the geographical position are accurately known.

The other particulars are ascertained at Medan, in the experimental grounds of the Deli Testing Station, by means of self-registering and other instruments; the monthly statements relating to these are no longer published, but are kept at the testing station at the disposal of persons interested; at the end of each year, however, the monthly averages are published.

(1) *Zoological Department.*

The Zoological Department of the Deli Testing Station has for its object the study of noxious animal life and the discovery of means to combat them, as well as the experimenting with useful animal life, and where necessary the introduction and incorporation thereof in the tobacco-growing region.

The most important pests are:—

Leaf-eating caterpillars: *Chloridea (Heliothis) obsoleta*, *Prodenia litura*, *Plusia* sp., *Botys marginalis*.

Gall-forming caterpillar: *Phthorimæa (Lita) solanella.*

Green-fly: *Aphis* sp.

Ants.

Beetles: *Opatrum* and its larva, the needle worm, *Lasioderma*, *Heterodera*.

Green bug: *Nezara*.

Whilst insecticides, both internal and contact poisons, were totally unknown in Deli about ten years ago, they are now very generally used.

Schweinfurt Green, imported by the Deli Testing Station in 1906, is now used annually in quantities of many thousands of kilograms (in 1913, 30,000 kilograms). The seed-beds, as well as the recently planted tobacco, is treated with this. In the case of the former the Schweinfurt Green, at a strength of 1 part per 1,000, is sprayed by means of a pump fitted with a powerful mixer, at the same time as the bouillie bordelaise. For tobacco in the field the insecticide at a strength of 1 per cent. is thoroughly mixed with tapioca flour, sifted dust, or a mixture of both; of this mixture, a small quantity is strewn into the hearts of the young plants from a pepper-box on the spot where the female of Heliothis prefers to lay her eggs.

A disadvantage of Schweinfurt Green is that, under certain circumstances, it produces a blight on the plants treated with it. Although such injury is not usually very serious, another insecticide free from this risk was imported, viz., arsenate of lead. As its action, however, is less powerful and less quickly destructive, it has to be used in a much more concentrated form (up to 4 per cent.), which renders it much more expensive than Schweinfurt Green. Hence its application, although blight is absolutely excluded, is less frequent than that of the first-named insecticide (in 1913, 9,000 kilograms).

Against the green-fly pest, which sometimes occurs in a very violent form, the following mixture has been recommended with great success:—

450 c.c. of 10 per cent. tobacco extract.
150 gr. green soap.
150 c.c. alcohol.
150 gr. soda.
200 c.c. water.

This quantity must be diluted with water to make up 15 litres.

Those estates which usually suffer from green-fly always stock this mixture in large quantities, in order to be able on the first appearance of the pest to syringe by means of a pump spray all affected plants. As an illustration of its effect, we may mention that on a certain estate the number of bales of tobacco has been reduced from 300 to 30 through the attack of green-fly.

Petroleum-soap emulsion against ants, which remove the seed from the seed drills, and a churner for its preparation, are generally in use at the instigation of the Deli Testing Station.

Of recent date also is the application on a large scale of carbon disulphide as an insecticide for *Lasioderma*. This small beetle settles in the piles of fermenting tobacco, in which it occasions extraordinary damage. In order to put an end to this destruction and to safeguard the unloaded bales of suspected tobacco against further attacks, they are, when quite ready for shipment, placed by hundreds at a time in hermetically sealed small sheds, and exposed for a certain time to the fumes of carbon disulphide. This will destroy all life without in any way affecting the quality of the tobacco. The crops of entire estates have been put on the market after having been disinfected in this way.

As parasites of the injurious insects appeared to be very scarce in Deli and very insignificant, it was considered advisable to try to import some from elsewhere, to increase them artificially, and to liberate them in the open, in order to combat the tobacco-damaging insects. With this object Dr. de Bussy made a trip to the United States in 1910, not only to try to import from there already known parasites, but also to study the methods adopted in that country. With the assistance of the Bureau of Entomology at Washington, he finally succeeded in transferring a number of different kinds alive from North America to Sumatra.

An assistant collected and cultivated the desired specimens in the south of the United States, and forwarded them in cold storage to Amsterdam, where another assistant formed an intermediate depot, and bred where necessary new generations; refrigerators were then again resorted to to retard development as much as possible on the voyage to the Dutch East Indies. There the various kinds were multiplied as fast as possible. The most important of these is *Trichogramma pretiosa*, which it is now possible to increase artificially almost in a wholesale manner; this little wasp parasitizes the eggs of a large number of insects, chiefly those of Heliothis, Prodenia, and Plusia. Hundreds of thousands of specimens of it are liberated annually in the tobacco plantations when it appears that there are many Heliothis eggs present. It has already been proved that this little wasp can maintain itself in a wild state for more than half a year, and there is therefore every reason to assume that it is either already a member of the fauna or will soon become one.

The propagation in the laboratory of a few other kinds of wasp which parasitizes the eggs or the caterpillars has not been successful, so that only a very small number of them could be liberated.

Certain Coccinellides (*e.g.*, *Megilla*, *Hippodamia*, *Chilocorus*, and *Coccinella*) which devour green-fly have been imported from America and Europe, but only in the case of *Megilla maculata* has it been found practicable to breed them on a large scale. From its very nature this beetle cannot, however, be produced in such large numbers in a short time as the small Trichogramma. Several thousands of the Megillas have been liberated annually at apparently suitable spots, but so far no specimens of succeeding generations which have developed entirely in a wild state have been found.

As maize is a very favourite plant of the female Heliothis on which to deposit her eggs, experiments have been made on a large scale with a view to utilizing this plant as a trap plant. The results varied greatly in different localities.

It was found that Prodenia is very fond of depositing its egg-nests on the large leaves of the very common *Limnocharis flava*, which came here from South America *viâ* Java; it appeared to be of importance to have this plant, which grows in ditches, regularly examined for Prodenia nests, not only when the tobacco is growing, but at other times also.

(2) *Agricultural Department.*

The work of this department consists in making cultivation trials with tobacco, both on the estates and on the trial grounds belonging to the Deli Testing Station.

Experiments with a view to determining the exact fertilizers required both on seed-beds and for growing tobacco plants were started by Dr. Diem in 1914 on a very extensive scale on about fifty estates, and so far the most surprising results have been obtained. Already known and new fertilizers are continually being tried in the testing grounds, both separately and in combination, and the most suitable amount to apply determined. It has been carefully ascertained which fertilizers may be mixed together, and a mixing diagram relating thereto, based on theoretical and practical considerations, has been issued.

As regards green manures, a number of Leguminosæ and other kinds, both collected here and imported from abroad, have been tested as to their suitability for this purpose, the possibility of their cultivation has been tried, and, according to the result obtained, they have been planted more or less extensively. The names of these plants, together with various details concerning them, are published in the Chronicles. Much attention also has been devoted to that category of plants which have an economic value and are capable of rendering the land productive when tobacco is not being grown (*e.g.*, maize, soy bean, sesame, sunflower, canavalia). The effect of various ways of tilling the ground and of different system of rotation on the tobacco is being studied at a number of places, part of this work being executed entirely by the companies concerned under the supervision of the testing station.

Experiments of this kind must necessarily be continued for a long time, their commencement is of too recent date to enable us to draw any definite conclusions from the results so far obtained.

Trials are also being conducted with regard to the development of the root system of the tobacco plant under varying conditions, with regard to the growth of the tobacco and of those kinds of plants as may be of use in the cultivation of the tobacco, with regard to the use of explosives in tilling the ground, the disinfection of the soil in seed-beds and for growing tobacco, and the effect of varying the distances between the seedlings in the seed-bed.

In order to study very carefully the influence of various circumstances on the tobacco plant pot-trials have been commenced, whereby a number of factors can be regulated at will. Important results have already been obtained by this means, and, in order to carry on these tests on a more extensive scale, a greenhouse is being built.

Attention continues to be directed to the possibility of extending the use of mechanical appliances for sowing, ploughing, etc. As far as possible experiments in this direction are being commenced in this department.

(3) *Botanical Department.*

The Botanical Department is occupied with the study of diseases of a vegetable nature affecting the tobacco plant and methods of combating them, together with selection and hybridizing experiments.

Particular attention is being paid to the slime-disease, the most dangerous of the vegetable diseases at the present time. Dr. Honing has definitely ascertained that this disease is of a bacterial nature, and is caused by *Bacillus solanacearum*, Smith. An extensive study of this, as well as of a number of other putrefying bacteria which are found in diseased tobacco stalks, has been made and published. It was shown that *Bacillus solanacearum* is very often present in the seedlings, and as a consequence the latter are now submitted to a very careful examination before they are planted out. Owing to its frequent appearance in well water, the latter is now disinfected with permanganate of potash ($\frac{1}{20}$ per cent.), of which in 1914 not less than 25,000 kilograms were used for that purpose. The application of various disinfectants to the soil in many cases caused the tobacco plants to remain alive for a longer period and to produce a larger crop of marketable leaves than they otherwise would have done, but they finally succumbed to the disease.

The ways in which infection is produced were carefully studied, as a result of which it was possible to issue a number of instructions for use in actual practice. A broadly conceived bacteriological investigation of the soil is now proceeding, from which it is hoped to obtain a clearer comprehension of the differences between healthy and slime-diseased lands, the appearance and the virulence of the bacteria, etc.

An immune variety is being sought for by obtaining at a number of affected places self-fertilized seed from plants which have remained healthy. As it was thought possible that a cross capable of resisting the slime-disease bacteria might be obtainable, a large number of foreign tobaccos have been tested with regard to their fitness in this respect. All these appeared to be just as little or even less proof against it as the Deli tobacco.

This disease has been found in a number of native plants, both cultivated and wild.

Another bacterial disease is the black rust, caused by *Bacterium pseudogloeæ*, a treatise on which by Dr. Honing appeared recently in the *Bulletin* of the Deli Testing Station.

Phytophthora nicotianæ chiefly attacks the seed-beds in Deli; on growing tobacco it is of little or no importance, with the exception of some isolated cases, when it may appear on the ripening leaves.

It has been the general practice for the last twenty years to water the nursery beds with bouillie bordelaise; lately it has been usual to dissolve the lime and the sulphate of copper in water, and to keep each separately in tightly closed bottles to prevent mistakes being made by the coolies in slaking the lime, etc.

Mosaic disease, which is chiefly spread by direct transfer from one plant to another, is being fought by omitting on the threatened estates the planting out of the seedlings, by protecting the seed-beds against the attacks of caterpillars by means of klamboes, which obviates the necessity of examining and touching the seedlings, and by keeping the caterpillars under control by the application of the above-mentioned insecticides.

Since 1906 the Deli Testing Station has been occupied with the isolation of pure strains of tobacco, the study of their behaviour, and the following up of this method in practice. Several strains have been successfully isolated, which has convinced planters of the advantage of this method of working, and at the present time many companies are in the habit of collecting self-fertilized seed from the best plants and sowing this separately later on.

The study of this subject is still in its infancy, and this year at a number of places comparative specimens have been planted between tobaccos derived from the seed of various estates.

In addition to an altogether excellent and pure strain —which has naturally to be sought for separately for each soil and for each climate—selection is also carried on with a view to obtaining immune varieties, especially in connection with the slime disease.

For crossing trials a very large number of foreign kinds of tobacco have been collected during the last few years from all parts of the world and planted out in the trial grounds. Presumably some of these will prove to be of value; a Japanese kind has already been planted out on one estate on a small scale, whilst the same kind is much appreciated at Djember in Java.

A study of the germinating power of tobacco seed has led to the following conclusions:—

(1) The germinating energy of tobacco seeds from large brown pods is higher than that from small dark brown seeds pods, but the difference is a small one.

(2) The germinating energy of large seeds is generally, but not always, greater than that of small seeds, and the difference is even smaller than the preceding.

(3) The germinating energy of heavy seeds is greater than that of light seeds, and this difference is much in excess of the two preceding ones.

The practical conclusion is that by the blowing out and removal of the lightest seed the germinating power (*i.e.*, germinating percentage after seven days) is increased to a greater extent than by selecting the seed pods or sifting the seed.

(4) *Chemical Department.*

The chemical section has just started a new method of soil examination, in order to obtain a better insight into the differences between the various kinds of soil and between healthy and diseased lands.

Previously to this a study of tobacco fermentation had been made by Dr. Tymstra. The results of this inquiry, including a study of various enzymes (oxydase, peroxydase, alpha- and beta-katalase), antioxydine, the destructive action of acids on peroxydase and the zymogen of the tobacco peroxydase, have been published in the organ of the Deli Testing Station.

Researches have likewise been conducted by Dr. Tymstra regarding the combustibility of tobacco, and a new method for determining this has been discovered.

Samples of soils obtained from the whole of the tobacco region have in course of time been physically and chemically examined; the percentages of nitrogen, phosphoric acid, potash, lime, chlorine, and fine earth were determined, as well as the absorption coefficient, the water capacity, volume, and specific gravity. The data obtained have been embodied in a study by Dr. Vriens and Dr. Tymstra, whilst the analyses have been conducted by the chemical assistant, Dr. Remmert.

Researches have also been made on the subject of the preparation of tobacco ash, which is valuable as potash manure, and is now being fairly generally prepared by planters from the tobacco stalks.

Attention must finally be drawn to the important part taken by the Deli Testing Station in the making of commercial analyses, the exercise of control over artificial manures, which are imported to the value of several hundred thousand guilders annually, the control of tobacco ash, of insecticides and fungicides, feeding stuffs, water samples, the testing of fermentation thermometers, the examination of suspected plant material, etc., etc.

A SHORT SURVEY OF THE TOBACCO CULTIVATION IN BESOCKI, JAVA.

By Dr. A. J. Ultée.

Director, Besocki Testing Station.

Amongst the various residencies of Java, where the cultivation of tobacco is carried on, Besocki occupies an important place. The crop of 1912-13, the latest year for which complete statistical details are available, amounted to no less than 41 million half kilograms, and was sold for more than 13⅓ million guilders; the corresponding figures for the whole of Java in that year were rather more than 121 and 30 million respectively.

In spite of the great importance of the industry it was not until 1912 that the Besocki planters followed the example of their colleagues of Deli and the Vorstenlanden and decided to obtain scientific guidance by establishing a local testing station. Want of harmony between the various estates was chiefly responsible for this delay, whilst some of the principal planters, moreover, could not agree with the manner in which, at that time, the Department of Agriculture co-operated with the existing testing stations.

It follows, therefore, that nearly the whole of the scientific work done in the Besocki residency on behalf of the tobacco industry is of very recent date, and only forms part of the working programme drawn up in the beginning of 1912 in conjunction with the Director of Agriculture.

Two varieties of tobacco are chiefly cultivated in Besocki; in the plains (up to about 600 ft.), the Deli variety is grown, the seed of which was originally imported from the East Coast of Sumatra; whilst in the higher regions (up to about 1,500 ft.) the Kedal variety is cultivated. The origin of the latter can no longer be traced, although there seems no doubt that it belongs to the Manila type and probably came from the Philippines.

These two varieties have now been cultivated for years in the midst of inferior native tobacco, and as sufficient precautions against cross-fertilization have not always been taken, it need scarcely be wondered at that plantations are far from regular and that fine plants are seen in the fields side by side with inferior sorts. It will be possible, therefore, to obtain a great improvement both as regards quantity and quality by selection, and this point has naturally been placed at the head of the working programme of the testing station.

In the 1912 campaign, with the aid of the administrators, a large number of fine tobacco plants were selected on the different estates with a view to studying their progeny in the following year in the experimental gardens of the testing station. The seed of each mother plant was obtained with due precautions against cross-fertilization and was sown separately in 1913. It will be the task of the testing station to choose from amongst the succeeding generations of the best strains the finest plant and to multiply the seed thereof for the estates.

As so many factors have to be taken into account in dealing with tobacco (such as burning quality, colour of the ash, taste, aroma, fineness of leaf, correct proportion of length to breadth, nervature and number of leaves), the work connected with the selection of these plants takes up much time, and other important questions will therefore, provisionally, have to receive less attention.

Hybrids also, which for some years past have been experimented with on one of the estates, may become of great importance in the cultivation of tobacco. There is this difficulty that, as the progeny naturally becomes diffused, it is necessary to cross each year afresh, which apart from the possibility of making mistakes, causes an expense in labour which cannot be overlooked.

The testing station has consequently devoted its attention also to crosses and will experiment with a view to finding hybrids which come true to seed. With this object several new kinds of tobacco have been imported from other countries, such as Japan, Hungary, North America, Brazil, etc. The seeds of Grecian and Turkish tobaccos, likewise imported, are being tested, however, with other objects.

It is well known that the consumption of cigars is increasing only slightly, whilst, on the contrary, the consumption of cigarettes increases enormously. It is necessary, therefore, for our tobacco planters to ascertain whether tobacco suitable for cigarettes can also be produced in this region. Experiments have not been carried on long enough to enable a definite opinion to be pronounced, but the first results are decidedly not discouraging.

Amongst the experiments of a chemical nature those made with fertilizers occupy a foremost place. As important advantages have often been obtained in other centres of tobacco cultivation by fertilizing, it was desirable to commence similar experiments in Besocki. It was, no doubt, to be expected that in East Java, with its younger soil, which has moreover been a shorter time under cultivation, the need of fertilizers would not be so great as in many other parts of Java, but only practical tests could furnish a decisive answer.

It has been shown that a potassium or phosphoric acid fertilizer produces little effect, but that, on the other hand, nitrogen exercises a favourable influence on the plants on many estates; not only is a larger production obtained, but the leaves are of greater dimensions, which, especially as regards wrappers and covers, offers a great advantage.

OILS AND OIL SEEDS.

PALMÖL IN DEN DEUTSCHEN KOLONIEN.

Von Direktor Fr. Hupfeld.
Deutsche Togo-Gesellschaft.

(I) Verbreitung der Oelpalme.

(*a*) *im allgemeinen.*

In der Beschreibung der sagenhaften Atlantis findet sich bei alten griechischen Schriftstellern die Angabe, dort wachse eine baumartige Pflanze, die den Eingeborenen Speise, Trank und Salböl liefere. Diese Angaben passen durchaus auf die Oelpalme; und wenn man bedenkt, dass schon die alten Karthager um 470 v. Chr. unter Hanno dem Aelteren auf dem Seewege bis nach Sierra Leone vorgedrungen sind, so wird es recht wahrscheinlich, dass tatsächlich die Oelpalme gemeint ist.

Sie war sicherlich schon damals eine der wichtigsten Pflanzen Westafrikas und ist auch heute für eine Reihe von Kolonien vom Senegal angefangen bis hinunter nach Angola die Lieferantin wertvoller Ausfuhrprodukte, des Palmöls und der Palmkerne.

Sie ist aber beschränkt auf die engste Tropenzone etwa zwischen dem 16. Grad nördlicher und dem 10. Grad südlicher Breite. Nach Osten dringt sie bis an die grossen Seeen in Centralafrika vor, darüber hinaus findet sie sich nur vereinzelt und zwar offenbar angepflanzt.

(*b*) *in Deutsch-Ostafrika.*

Für Deutsch-Ostafrika hat sie also, abgesehen von der Deckung des Eingeborenenbedarfs an Speisefett und Salböl an den grossen Seeen, vorläufig keine wirtschaftliche Bedeutung. Ob ihre Anpflanzung, die jetzt mehrfach versucht wird, sich bewähren wird, bleibt abzuwarten.

(*c*) *in Togo.*

Anders in den westafrikanischen Tropenkolonien Togo und Kamerun. Hier sind die Produkte der Oelpalme die weitaus wichtigsten Handelsartikel, ja—abgesehen von dem Kautschuk Südkameruns—das Rückgrat des gesamten Ausfuhrhandels und damit naturgemäss indirekt auch massgebend für Umfang und Prosperität des Einfuhrhandels.

Allerdings findet sich die Oelpalme auch in diesen Kolonien keineswegs überall. Die Höhe von 1,000 m, die freilich in Togo nur an wenigen Punkten erreicht, in Kamerun aber auf grosse Gebiete überschritten wird, kann praktisch annähernd als obere Grenze ihres Gedeihens bezeichnet werden. Sie verlangt ferner gewisse Niederschlagsmengen in nicht zu ungünstiger Verteilung; gegen längere Trockenheit ist sie recht empfindlich. So wächst sie in der nördlichen Hälfte der Togokolonie nur an besonders günstigen Orten mit Grundfeuchtigkeit, weil die an sich wohl ausreichenden Niederschlagsmengen von 1,200-1,600 mm. sich dort auf eine Hauptregenzeit beschränken, der eine ausserordentlich scharfe Trockenzeit von 4-6 Monaten Dauer folgt. Ebenso fehlt die Oelpalme an der Küste von Togo, deren jährliche Regenmenge von 700-800 mm. für sie um so weniger ausreicht, als hier zeitweise Jahre mit abnorm langer Trockenzeit oder mit besonders niedrigen Regenmengen auftreten. Dieser niederschlagsarme Küstenstreifen ist aber nur 10-15 km. breit, dann folgt eine Zone von etwa 1,000 mm. Regenmenge in verhältnismässig viel besserer Verteilung: hier zieht sich ein breiter Streifen, die sog. Oelpalmenzone, quer durch die Kolonie mit zahlreichen Oelpalmen, die zum grossen Teil von den Eingeborenen angepflanzt sind, aber freilich nicht durchweg unter Kultur gehalten werden.

Weiter im Innern in den Bezirken Misahöhe und Atakpame sind grössere Oelpalmenbestände vor allem am Fusse der Gebirge und in feuchten Tälern, auch entlang den Wasserläufen. Ferner findet sich die Oelpalme recht zahlreich in den meist auf die Gebirge Mitteltogos beschränkten Urwäldern, dagegen tritt sie in der Steppe, die ja jährlich in der Trockenzeit abgebrannt wird, ganz zurück.

Trotz des ausgedehnten Vorkommens der Oelpalme in Süd- und Mitteltogo muss man sich doch darüber klar sein, dass sie das optimum ihrer Lebensbedingungen in der Togokolonie nicht findet. Inwieweit die Qualität des Bodens, der in Togo im allgemeinen nicht besonders gut ist und speziell Mangel an Kali, Phosphorsäure und Kalk zeigt, dabei mitspricht, ist noch unsicher, da über die Anforderungen, die die Oelpalme an den Boden stellt, noch keine einwandfreien Untersuchungen vorliegen. Sicher ist aber, dass die durchschnittliche Gesamtregenmenge von 1,000 mm. in der sog.Oelpalmenzone und die bis unter diesen Betrag in manchen Jahren heruntergehende Niederschlagsmenge der an sich regenreicheren Gebiete am und im Gebirge der unteren zulässigen Grenze recht nahe kommen, sicher ist auch, dass die in Togo doch recht scharf ausgeprägte Trockenzeit mit ihrem ausdörrenden Harmattanwinde der Oelpalme nicht zusagt.

So kann es denn nicht wunder nehmen, dass die Erträge der Oelpalme in Togo keineswegs stetige, sondern je nach den Witterungsverhältnissen überaus schwankende sind.

(*d*) *in Kamerun.*

Das liegt in Kamerun ganz anders. Hier findet die Oelpalme in den regenreichen Urwäldern der ausgedehnten Tiefländer ausserordentlich günstige Lebensbedingungen, und wenn sie auch vielleicht von den Eingeborenen nicht so viel angepflanzt worden ist wie in Togo, so findet sie sich doch schon wild in sehr grossen Mengen. Ihre Verbreitung macht nur halt da, wo das Land sich zu hoch über das Meer erhebt, und da, wo an die Stelle des Waldes die Steppe mit ihren jährlichen Grasbränden tritt.

Dem entspricht es denn auch, dass die Oelpalmen in Kamerun rascher wachsen, kräftiger aussehen, grössere Früchte geben als in Togo, und dass auch die Ausfuhr an Palmöl und Palmkernen in Kamerun einen viel stetigeren Charakter hat als dort.

(II) Die Produkte der Oelpalme.

Die Oelpalme liefert den Eingeborenen eine Reihe von Produkten, von denen die für sie wichtigsten das Palmöl, die Palmkerne und der Palmwein sind. Letzterer spielte vor Einführung europäischer Spirituosen eine recht wichtige Rolle im täglichen Leben der Eingeborenen und tut das bis zu gewissem Grade noch heute.

Zu seiner Gewinnung wird die Palme gefällt, und so werden zehntausende von Oelpalmen jährlich lediglich der Palmweingewinnung wegen vernichtet, wobei allerdings zu berücksichtigen bleibt, dass die Oelpalmen in wilden wie in angepflanzten Beständen im allgemeinen viel zu dicht stehen, so dass eine Durchlichtung nur von Vorteil ist.

Die Palmkerne werden von den Eingeborenen zur Gewinnung des Palmkernöls benutzt, das zum Backen verwendet wird. Doch hat diese Ausnutzung in Togo und Kamerun einen so geringen Umfang, dass sie ziffernmässig kaum in's Gewicht fällt. Wohl aber sind für den europäischen Handel die Palmkerne von grösster Bedeutung.

Das Palmöl endlich ist eines der wichtigsten Lebensmittel für den Eingeborenen, sein Hauptlieferant für Fett; denn die tierischen Fette, besonders Butter, kommen für ihn nicht in Betracht, da ihm das Melken im allgemeinen ganz unbekannt ist und der Milch-, also auch Buttorertrag da, wo man das Melken kennt, wie bei den nomadisierenden Viehzucht treibenden Fulbestämmen, doch nur sehr gering ist. Da die üblichen Nahrungsmittel des Eingeborenen, wie Yams, Bananen, Kassada u. dgl. kein Fett enthalten, ist sein Bedarf an Palmöl schon für Speisezwecke ausserordentlich hoch. Ausserdem braucht er es aber auch zum Einsalben des Körpers und zur Herstellung von Seife.

Für den Europäer ist das Palmöl ein ebenfalls recht wertvoller Handelsartikel, dessen Wert in Europa etwa die Hälfte höher ist als derjenige einer gleichen Menge von Palmkernen; wobei allerdings Palmöl wesentlich höhere Spesen verursacht.

(III) Die bisherige Gewinnung des Palmöls.

Die Gewinnung des Palmöls war bis vor kurzem ausschliesslich Sache der Eingeborenen, ihre Methode ist naturgemäss eine verhältnismässig primitive. Die aus den Fruchtbündeln ausgelesenen Früchte werden in trichterförmigen mit Steinen ausgelegten Gruben mit heissem Wasser übergossen und mit hölzernen Stangen zerstampft. Das Oel schwimmt dann oben, zum Teil wird es auch ausgepresst und dann noch durch Kochen gereinigt.

Die Palmnüsse werden von Hand mit Stein auf Stein aufgeschlagen, um die Palmkerne zu gewinnen, eine an sich recht mühsame Arbeit, die aber von dem Neger nicht so hoch veranschlagt wird, weil sie jederzeit und auch durch Weiber, Kinder und Greise vorgenommen werden kann. Die Leute sitzen dann plaudernd zusammen und das Palmkerneknacken hat für sie etwa dieselbe Bedeutung wie sie bei unsern Müttern und Grossmüttern der Strickstrumpf besass.

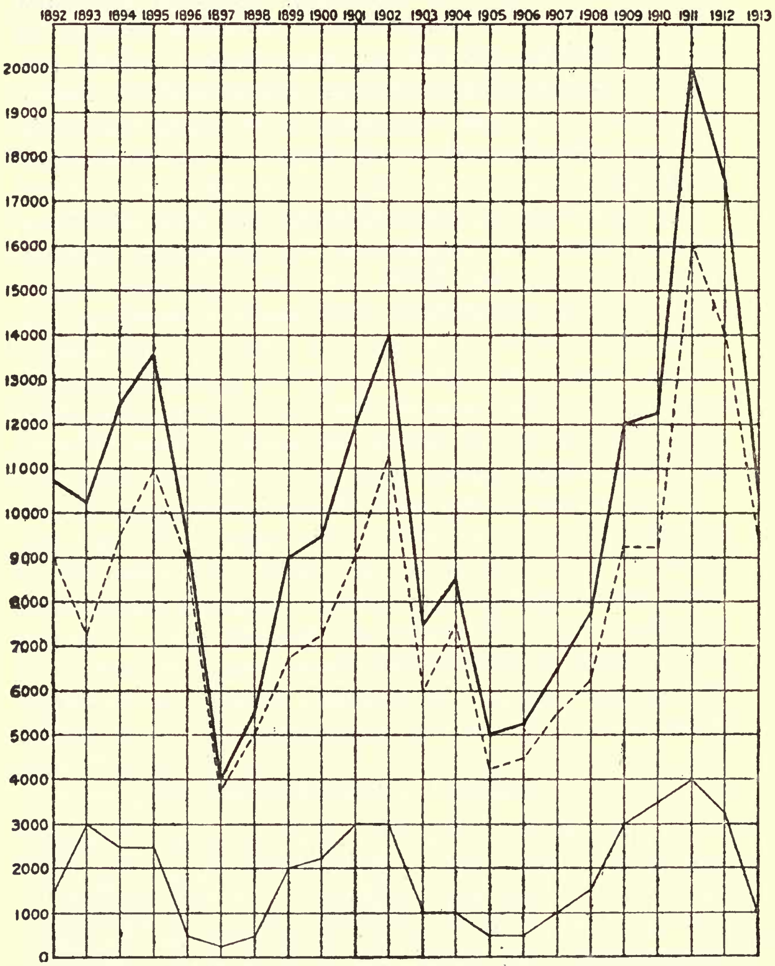
Die Palmölgewinnung nach Eingeborenenart liefert bei entsprechender Vorsicht ein recht gutes Oel, im allgemeinen wird aber doch ein Palmöl von hohem Fettsäuregehalt (meist über 20 Prozent) und mit reichlichem Schmutz- und Wassergehalt erzeugt. Es ist in europäischen Fabrikbetrieben daher praktisch nicht für Speisefettfabrikation verwendbar, sondern wird überwiegend in der Seifenindustrie verbraucht.

(IV) Bisherige Produktionsmengen.

Von besonderem Interesse wäre es natürlich, wenn man einen Anhalt dafür bekommen könnte, wie viel Palmöl die Eingeborenen überhaupt zur Zeit herstellen. Wir haben keine Möglichkeit diese Ziffer für die dem Handel noch nicht erschlossenen Gebiete zu schätzen. Wohl aber gibt uns bei den dem Handel erschlossenen Bezirken die Menge der Ausfuhr an Palmkernen einen Fingerzeig.

Wir erwähnten bereits, dass der Eigenverbrauch an Palmkernen unberücksichtigt bleiben kann. Es ist ferner bekannt, dass im allgemeinen wohl nicht viele Palmkerne gewonnen werden, ohne dass aus den entsprechenden Früchten auch das Palmöl hergestellt wurde. Wir wissen

I.—Togo.



——— vermutliche Gesamtproduktion an Palmöl (in den für Ausfuhr in Betracht kommenden Bezirken).

- - - - - - - - davon Ausfuhr.

——— Selbstverbrauch an Palmöl.

ferner, dass die Eingeborenen aus den Palmfrüchten zwischen 10 bis 16 Prozent Palmöl und 10 Prozent Palmkerne erzielen. Man wird daher annehmen dürfen, dass auf 10 kg. Palmkernausfuhr zwischen 10 bis 16 kg. Palmöl hergestellt worden sind. Nehmen wir dieses Verhältnis mit 10:15 an, so gibt uns die Palmkernausfuhr einen ungefähren Anhalt dafür, wie viel Palmöl in den dem Palmkernhandel erschlossenen Gebieten, sei es für eigenen Verbrauch, sei es zur Ausfuhr mindestens hergestellt worden ist, wobei allerdings dasjenige Palmöl ausser Rechnung bleibt, bei dem die entsprechenden Palmkerne nicht gewonnen worden sind. Auf dieser Grundlage sind die beiden anliegenden grafischen Darstellungen berechnet, welche für Togo und für Kamerun angeben: —

(1) Wie viel Palmöl in den dem Palmkernhandel erschlossenen Gebieten vermutlich insgesamt mindestens produziert worden ist.

(2) Wie viel davon vermutlich von den Eingeborenen selbst verbraucht worden ist.

(3) Wie viel nach den statistischen Ausweisen tatsächlich ausgeführt worden ist.

Diese Ziffern sind selbstverständlich nicht exakt, man wird gegen sie manche Einwendungen erheben können, sie werden aber als erster Versuch der Schätzung der Gesamtproduktion eines Verbrauchsartikels der Eingeborenen immerhin ein gewisses Interesse bieten.

Es lassen sich aus ihnen nachstehende Folgerungen ziehen: —

(1) Der weitaus grösste Teil des von den Eingeborenen gewonnenen Palmöls wird von ihnen selbst verbraucht, nur ein recht kleiner Teil wird von ihnen an den Europäer verkauft und von diesem exportiert.

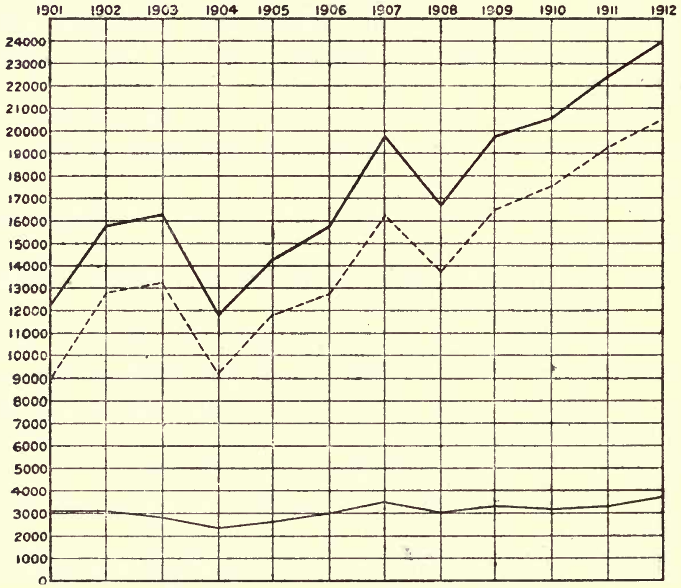
(2) Berechnet man den Durchschnitt der Jahre 1901 bis 1912, so erhält man folfende Ziffern:

T o g o exportierte jährlich ...	7,079 t.	Palmkerne.	
die jährliche Palmölgewinnung in den für Ausfuhr in Betracht kommenden Gebieten war vermutlich mindestens	10,619 t.		
tatsächlich wurden ausgeführt	2,043 t.	=	19%
mithin im Lande verbraucht ...	8,576 t.	=	81%

Kamerun exportierte jährlich ... 11,684 t. Palmkerne.
vermutliche Palmölgewinnung
mindestens ... ... 17,526 t.
davon tatsächlich ausgeführt 3,115 t. = 18%
mithin im Lande verbraucht ... 14,411 t. = 82%

In beiden Kolonien werden also mehr als $\frac{4}{5}$ des Palmöls von den Eingeborenen selbst verbraucht, knapp $\frac{1}{5}$ kommt zur Ausfuhr.

II.—Kamerun.



——— vermutliche Gesamtproduktion an Palmöl (in den für Ausfuhr in Betracht kommenden Bezirken).

- - - - - - - - davon Ausfuhr.

——— Selbstverbrauch an Palmöl.

(3) Eine Zunahme der Produktion an Palmöl hat in erster Linie eine Steigerung des eigenen Verbrauchs zur Folge, eine gleichzeitige Steigerung der Ausfuhr ist in Kamerun überhaupt nicht festzustellen, in Togo zeigt sie sich zwar, aber doch bei weitem nicht in dem Umfange, den man eigentlich vermuten sollte.

Dabei ist aber zu berücksichtigen, dass die Ziffern in den einzelnen Jahren sich nicht auf dieselben Gebiete erstrecken, sondern jeweils diejenigen Teile der beiden

Kolonien umfassen, aus denen nach Lage der Verkehrswege und Transportkosten die Ausfuhr an Palmkernen und Palmöl überhaupt möglich ist. Die sehr starke Zunahme in Kamerun seit 1909 ist also nicht eine tatsächliche Mehrproduktion, sondern entspricht infolge des Baues der Nordbahn und anderer Verkehrswege der Ausdehnung des für Ausfuhr in Betracht kommenden Gebietes und der infolgedessen tatsächlich erzielten Mehrausfuhr an Kernen.

Sehr auffallend ist es, dass in Kamerun seit 12 Jahren keine Steigerung der Palmölausfuhr zu beobachten ist, ja der Anteil des tatsächlich ausgeführten Palmöls an dem im ausfuhrfähigen Gebiete insgesamt erzeugten Palmöl ist sogar in dem Jahrsechst 1907-1912 auf 16 Prozent gegen 20 Prozent in 1901-1906 zurückgegangen.

Dabei spricht sicherlich die Ernährung der steigenden Mengen von Arbeitern im Plantagenbau und beim Bahnbau der Küstennahen Bezirke mit, welche ansehnliche Mengen von Palmöl in Anspruch nimmt, ausserdem dürfte aber der Verbrauch an Palmöl auch bei den übrigen Eingeborenen der Küstengebiete, besonders der Stadt Duala zugenommen haben.

Die Kurve für Kamerun lässt gleichzeitig bei Berücksichtigung der Vergrösserung der Verkehrswege erkennen, dass die Ernten an sich keinen sehr erheblichen Schwankungen ausgesetzt sind, eine Folge der für die Oelpalme ausserordentlich günstigen natürlichen Bedingungen der für Ausfuhr in Betracht kommenden Teile der Kolonie.

Wesentlich anders ist in dieser Beziehung das Bild in Togo. Hier wechseln erfahrungsgemäss Perioden von regenreichen und regenarmen Jahren ab, und da die Niederschlagsmengen an sich nicht hoch sind, sinken sie in den Dürreperioden tief unter das für die Oelpalme erforderliche Mass. Demgemäss sinkt in diesen Zeiten die Erntemenge und zwar äussert sich der Rückgang statistisch in der Regel in dem auf das betreffende Dürrejahr folgenden Jahre. Die weitere Rückwirkung auf die Einfuhrstatistik zeigt sich dann in der Regel noch ein Jahr später.

In den armen Jahren sinkt naturgemäss die Palmölausfuhr auf ein Minimum, zugleich aber auch sehr stark der Eigenverbrauch, ja man wird annehmen dürfen, dass die Eingeborenen in solchen Zeiten an Fett geradezu Mangel leiden; dafür halten sie sich in guten Jahren durch einen auf das Doppelte des Durchschnitts gesteigerten Verbrauch schadlos.

Die Wirkung des Eisenbahnbaus macht sich statistisch auch in Togo bemerkbar. Die im Jahre 1907 eröffnete Palimebahn hat beträchtliche Gebiete mit Oelpalmen erschlossen, und auch die in den folgenden Jahren erbaute Atakpamebahn hat das ausfuhrfähige Gebiet stark vergrössert, wenn auch hier grosse Strecken für Oelpalmenkultur nicht in Frage kommen. Besonders wichtig ist es, dass die Gebirgslandschaften an sich höhere Regenmengen und auch geringere Schwankungen in der Regenverteilung aufweisen als Südtogo. Dem Bahnbau ist es daher in der Hauptsache zuzuschreiben, dass die Kurve der Palmkernausfuhr in 1911 sehr viel höder hinaufführt als in den früheren Rekordjahren 1895 und 1902, und seiner Einwirkung wird es zu verdanken sein, wenn sie bei dem jetzigen Rückgang nicht wieder so tief sinkt wie 1897 und 1905.

Trotzdem werden aber sehr grosse Schwankungen im Wirtschaftsleben dieser Kolonie bestehen bleiben, solange es sich in der Hauptsache auf der Oelpalme aufbaut.

(V) Bisherige Ausfuhrwerte.

Wie der Menge so auch dem Werte nach fallen in Togo wie in Kamerun Palmkerne und Palmöl stark ins Gewicht. Die Ziffern stellen sich nach der amtlichen Ausfuhrstatistik, wie folgt:—

	Im Jahresdurchschnitt.	1901—1906. M	1907—1912. M	1901—1912. M
Togo ...	Palmkerne für	1,114,000	2,094,000	1,604,000
	Palmöl für	603,000	1,027,000	815,000
		1,717,000	3,121,000	2,419,000
Kamerun ...	Palmkerne für	1,865,000	3,299,000	2,582,000
	Palmöl für	949,000	1,287,000	1,118,000
		2,814,000	4,586,000	3,700,000

Demgegenüber betrug der Gesamtwert der Ausfuhr: —

Im Jahresdurchschnitt.	1901—1906.	1907—1912	1901—1912
In Togo (ohne Geld) ... ... Palmkerne + Palmöl also ...	2,995,000 M 57%	6,174,000 M 50%	4,585,000 M 54%
In Kamerun (einschl. Geld) ... Palmkerne + Palmöl also ...	7,961,000 M 35%	18,045,000 M 25	13,003,000 M 28%

Aus obigen amtlichen Ziffern ergibt sich ferner, dass man als Durchschnittswert im Ausfuhrhafen der Kolonie zu Grunde gelegt hat: —

	Für 1 t.	1901—1906. M	1907—1912. M	1901—1912. M
Togo ...	Palmkerne ... ... Palmöl	195 405	248 396	226 399
Kamerun ...	Palmkerne ... ... Palmöl	194 328	255 386	221 359

Die Ziffern spiegeln die Wertsteigerung wieder, die Palmkerne im Laufe der Jahre erfahren haben, seit sie in Europa in steigendem Masse in der Speisefettindustrie Verwendung finden. Im übrigen sind aber die den Ausfuhrwerten amtlich zu Grunde gelegten Ziffern derartigen Zufälligkeiten unterworfen, dass es sich nicht lohnt, sie einer näheren Kritik zu unterziehen.

Wesentlich einwandsfreier sind die auf den europäischen Märkten notierten Preise. Sie stellten sich wie folgt: —

Bei Palmkernen betrug der Preis für Togokerne je 50 kg. in Hamburg im Jahre 1901 durchschnittlich 11.50 M, stieg 1902 auf 13 M, um 1903 auf 11 M zurückzugehen. Er stieg dann wieder auf 12.50 M in 1904, 13.50 M in 1905, fast 15 M in 1906 und 16.30 M in 1907. Das Jahr 1908 brachte einen Rückgang auf 13.25 M, die folgenden Jahre aber stetige Zunahme auf 15 M, 18 M, 18 M und 19 M.

Bei Palmöl bewegte sich der Preis für 50 kg. im Jahresdurchschnitt von 1901 bis 1905 zwischen 23.25 M und 25 M, das Jahr 1906 brachte eine Steigerung auf

26 M, 1907 auf 29.50 M, während der Preis 1908 auf 24.25 M zurückging und auch 1909 nur 1 M mehr betrug. Im folgenden Jahre aber folgte eine scharfe Erhöhung auf 31.25 M, von der der Preis im Jahre 1911 auf 30 M, 1912 auf 28.50 M zurückging, dabei aber doch noch einen recht hohen Stand behaltend.

Man kann ohne weiteres annehmen, dass im allgemeinen die von den Kaufleuten beim Produkteneinkauf drüben den Eingeborenen bezahlten Preise diesen Schwankungen der heimischen Marktpreise gefolgt sind.

Vergleicht man letztere nun mit den tatsächlichen Ausfuhrziffern wie auch mit dem Prozentsatze des ausgeführten Palmöls, so wird man keinerlei nachweisbaren Einfluss erkennen können. Wohl wird selbstverständlich bei hohen Preisen das Gebiet, aus welchem man noch exportieren kann, entsprechend grösser, allein das fällt nicht derart ins Gewicht, als dass man es in den obigen Gesamtziffern nachweisen könnte. Von diesem besonderen Falle abgesehen ist es aber innerhalb gewisser Grenzen ohne jeden Einfluss auf die Ausfuhr, ob die Preise hoch oder niedrig sind.

Die Ausfuhr an Palmkernen aus den ausfuhrfähigen Gebieten ist in der Hauptsache bedingt durch die Gesamt-Produktion an Palmöl, und diese wiederum hängt ab von den Witterungsverhältnissen (besonders in Togo) und dem Eigenverbrauch. Witterung und Eigenverbrauch sind also fast ausschliesslich massgebend für den Umfang der Oelpalmenkultur, soweit man von einer solchen reden kann, und der Palmfruchtnutzung. Ferner ist der Prozentsatz an Palmöl, der zur Ausfuhr gebracht wird, nicht nachweislich abhängig von den erzielten Preisen.

Innerhalb vernünftiger Grenzen, für deren Einhaltung erfahrungsgemäss ja schon die Konkurrenz der kaufmännischen Firmen unter einander sorgt, ist es ganz gleichgültig, ob der Kaufmann etwas höhere oder niedrigere Preise bezahlt, und es liegt nicht in der Macht des Kaufmanns, durch Preisgestaltung, ja selbst durch Verzicht auf jeden Gewinn die tatsächliche Ausfuhrmenge nennenswert zu beeinflussen.

Für denjenigen, der den Charakter des gewöhnlichen Negers in Togo und Kamerun kennt, bietet diese Folgerung aus der Statistik nichts Neues. Sie muss hier aber hervorgehoben werden, weil vielfach—nicht zum wenigsten bei der Regierung, aber auch in kaufmännischen Kreisen—diese Fragenlediglich nach heimischem Massstabe gemessen und daher völlig verkannt werden.

(VI) Möglichkeiten der Ausfuhrsteigerung.

Dass eine Steigerung der bisherigen Ausfuhrmengen im Interesse der heimischen Volkswirtschaft dringend zu wünschen ist, zeigt ein Blick auf die enorme Steigerung des Bedarfs vegetabilischer Fette in den Kulturstaaten. Dass sie möglich ist, steht ohne weiteres ausser Zweifel. Erzielen lässt sie sich theoretisch durch folgende gegebenenfalls natürlich zu vereinigende Möglichkeiten:—

(*a*) Ausdehnung des ausfuhrfähigen Gebietes durch Verbesserung der Verkehrswege,

(*b*) intensivere Ausnutzung der vorhandenen Bestände durch bessere Kulturmethoden,

(*c*) bessere Ausnutzung der erbielten Ernten durch bessere Aufbereitungsmethoden,

(*d*) Vergrösserung der vorhandenen Bestände durch vermehrte Tätigkeit der bisherigen oder Heranziehung neuer Produzenten.

(*a*) *Bau von Verkehrswegen.*

Der Bau von Verkehrswegen, insbesondere von Eisenbahnen, ist selbstverständlich eine der wichtigsten, zugleich aber auch in gewissem Sinne einfachsten Massnahmen zur Hebung kolonialer Produktion.

Was speziell die Oelpalme anbetrifft, so sind nachweislich im Innern von Kamerun in den riesigen Urwaldgebieten sehr grosse, auch nicht annähernd zu schätzende Bestände von Oelpalmen vorhanden, deren wirtschaftliche Ausnutzung für Ausfuhrzwecke zur Zeit ganz unmöglich ist, aber sofort einsetzen würde, wenn entsprechende Verkehrswege vorhanden wären. In dieser Richtung bietet die Kamerunkolonie noch Zukunftsaufgaben, die weder unsere noch die nächste Generation voll wird erfüllen können, an deren Lösung aber jetzt mit Energie und Aufwendung grosser Mittel gearbeitet wird.

Die sofortige volle Nutzbarmachung der durch den

Eisenbahnbau geschaffenen Entwicklungsmöglichkeiten wird freilich durch den Mangel genügend zahlreicher Arbeitskräfte, niederen Kulturstand und Bedürfnislosigkeit, daher Mangel an Arbeitslust sehr vieler Volksstämme, endlich durch Seuchen und andere weitverbreitet Krankheiten stark beeinträchtigt werden.

In Togo liegen die Verhältnisse anders. Da Nordtogo keine nennenswerten grösseren Oelpalmenbestände besitzt und Süd- und Mitteltogo schon ziemlich gut durch Bahnen und Wasserwege erschlossen sind, würde der Bau von Eisenbahnen das ausfuhrfähige Gebiet an sich nicht mehr viel vergrössern können. Auch die sog. Oelbahn in das Hinterland von Anecho wird das nicht tun, da man Palmöl und Palmkerne von dort schon heute exportieren kann. Wohl aber würde diese Bahn ein wichtiger Schachzug gegenüber den Eisenbahnplänen in Dahomey sein, indem sie die deutschen Produkte dem deutschen Verschiffungsplatze zuführte, und zugleich würde sie wie jede andere Eisenbahn in Afrika durch Ersetzung des Trägerverkehrs Arbeitskräfte für produktive Tätigkeit frei machen.

Aehnliches gilt von der von den kaufmännischen Kreisen vorgeschlagenen Verlängerung der Palimebahn über das Hauptgebirge hinweg in den Kpandubezirk.

(b) Bessere Kulturmethoden.

Die Ausnutzung der vorhandenen Oelpalmenbestände in den erschlossenen Gebieten ist bisher durchaus mangelhaft. Grosse Mengen von Oelpalmen selbst in nächster Nähe von Eisenbahnen werden noch so gut wie gar nicht ausgenutzt. Vor allem stehen die Palmen viel zu dicht bei einander, oder sie sind im Urwald von anderen Bäumen eingeengt. Die Oelpalme verlangt aber Licht und Luft, sonst trägt sie überhaupt fast gar nichts. Und auch bei denjenigen Beständen, die von den Eingeborenen in eine Art Kultur genommen werden, findet man durchweg eine viel zu geringe Standweite.

Dazu kommen andere Fehler, so die Gewohnheit der Eingeborenen, beim Reinigen ihrer Farmen zwischen den stehen gelassenen Oelpalmen ruhig zu brennen, wodurch letztere für Jahre hinaus geschädigt werden.

Darin Wandel zu schaffen, wird eine der wichtigsten landwirtschaftslichen Aufgaben der Regierung sein. Sie wird auch darauf zu dringen haben, dass das Palmenfällen zur Palmweinbereitung in gewissen Grenzen bleibt, dass ferner gutes Saatgut zum Auspflanzen genommen wird, dass man die Eingeborenen allmählich anlernt zu düngen u. s. w. Zugleich wird sie die bisher noch nicht ganz geklärten Kulturbedingungen der Oelpalme zu studieren und die Ergebnisse des Studiums in die Praxis umzusetzen haben.

Ohne einen gewissen Zwang wird man dabei nicht durchkommen. Das hat das Gouvernement von Togo auch bereits erkannt, denn es will den Dorfschaften in den Oelpalmenbezirken die Inkulturnahme bestimmter Flächen vorschreiben.

Das alles lässt sich aber nur mit ausreichendem Personal durchführen, und es ist durchaus anzuerkennen, dass die Regierung in dieser Beziehung seit einigen Jahren recht grosszügig und systematisch vorgeht.

Recht wertvoll für die Erziehung der Eingeborenen wäre es natürlich, wenn sie die verbesserten Kulturmethoden auf europäischen Plantagen sehen und sich so von ihrer Zweckmässigkeit überzeugen könnten.

(*c*) *Bessere Aufbereitungsmethoden.*

Die Aufbereitungsmethode der Eingeborenen hat den Vorteil sehr einfach und überall, wo man nur Wasser hat, anwendbar zu sein. Dem stehen aber schwerwiegende Nachteile gegenüber. Die Methode verlangt unverhältnismässig viel Arbeitskräfte, und wenn auch die Palmölgewinnung noch rentabel bliebe, so wäre doch an eine Verwertung der Palmnüsse nicht zu denken, wenn man die verwendete Arbeitskraft auch nur annähernd nach den üblichen Lohnsätzen bezahlen müsste. Eine Verwertung von Palmfrüchten durch Europäer und demgemäss die Kultur der Oelpalme durch Europäer war und ist ausgeschlossen, wenn man die Früchte nach Eingeborenenart durch bezahlte Arbeiter verarbeiten lassen will.

Dazu kommt, dass das auf diese Weise gewonnene Palmöl meist einen recht hohen Fettsäuregehalt (über

20 Prozent) besitzt und durch Schmutz und Wasser verunreinigt ist, und dass auch der Wert der Palmkerne durch hineingeratene Schalenreste beeinträchtigt wird.

Seit etwa 12 Jahren wird nun in deutschen, französischen und englischen Kolonien das Problem einer verbesserten Methode der Palmfruchtverarbeitung studiert; in jenen gab das Kolonialwirtschaftliche Komitee die Anregung. Als erster baute Fr. Haake in Berlin eine Anlage, welche auf dem sog. nassen Wege arbeitete; bald darauf suchte Fournier in Cotonou durch sein sog. trockenes Verfahren dasselbe Ziel zu erreichen. Andere Fabrikanten folgten, wie Krupp Grusonwerk in Magdeburg-Buckau, Behnisch in Luckenwalde, M. Martin in Bitterfeld, Humboldt in Cöln-Kalk, Luther in Braunschweig.

So entstanden eine Reihe verschiedener Konstruktionen und Verfahren, die zum grossen Teil noch ständigen Veränderungen unterworfen sind. Es wird schwer sein. schon heute zu entscheiden, wem endgültig der Vorzug zu geben sein wird, so viel aber lässt sich sagen, dass die von der Agupflanzung in Togo im regelmässigen Betriebe nun schon seit längerer Zeit erzielten Ergebnisse zur Zeit die günstigsten sind, soweit die Resultate der in verschiedenen Kolonien bestehenden Palmölwerke bekannt sind. Es sei daher gestattet, im nachfolgenden dieses sog.Aguverfahren zu schildern.

Die reifen Fruchtbündel werden von den Palmen abgeschlagen, wobei es wichtig ist, den richtigen Reifegrad abzupassen, da unreife Früchte ein ungünstiges Ausbringen haben, in überreifen aber sich bereits Fettsäure entwickelt hat. Die Fruchtbündel werden sofort auf Wagen (Feldbahn) zur Fabrik gebracht und dort unverzüglich verarbeitet; jeder Aufschub erhöht den Fettsäuregehalt. Von dem Fruchtbündel werden die Rispen, in denen die Früchte sitzen, mit diesen abgeschlagen und in grossen Pfannen durch Einströmen von heissem Dampf eine Stunde lang auf etwa 100° C. erhitzt. Dadurch werden alle Keime getötet und so das Entstehen weiterer Fettsäure verhindert. Die heisse Masse kommt dann in das Stampfwerk.

Dieses von Humboldt nach den Vorschlägen des Unterzeichneten gebaute Stampfwerk ist der charakteristische Teil der Fabrik der Agupflanzung. Es besteht aus einer Anzahl schwerer in einer Reihe neben einander stehender Pochstempel, welche in einen schwach geneigten länglichen Trog hinunterfallen; doch können sie nicht bis auf den Boden des Troges fallen, weil sie durch eine auf ein Gummipolster aufschlagende Nase arretiert werden. Der Trog, an dessen oberem Ende die Fruchtmasse eingeschüttet wird, besteht aus doppelwandigem Eisen und wird mit Dampf erhitzt. Durch das Stampfen werden die Früchte aus den Rispen herausgeschlagen und zugleich ganz zerquetscht, so dass die Zellen zersprengt werden. Dabei bleiben die Palmnüsse unversehrt, weil der Zwischenraum zwischen dem herabfallenden Pochstempel und dem Boden des Troges entsprechend berechnet ist. Das Stampfen im Stampfwerk ermöglicht es, später mit einmaliger Pressung auszukommen, während alle anderen trockenen Verfahren zweimalige Pressung vorsehen.

Die gestampfte Masse, welche Rispen, Fruchtfleisch und Palmnüsse enthält, fällt in eine mit Dampf geheizte Auffangpfanne und kommt sodann in eine hydraulische Presse, in welcher mit 250 Atmosphären gearbeitet wird. Das ausgepresste Oel läuft ab und trennt sich in einem entsprechend eingerichteten Bassin von dem meisten aus den Früchten stammenden Wasser. Es wird sodann durch Sieden in grossen Dampfkochkesseln von dem Reste des Wassers und zugleich von Schmutz befreit.

Die Pressrückstände, bestehend aus Rispen, Fasern und Nüssen, gehen zunächst über ein Sieb, welches die Rispen zurückhält. Die Fasern und Nüsse gelangen sodann in eine von Luther gebaute rotierende Siebtrommel, durch welche die Fasern hindurchfallen, während die Nüsse am Ende der Trommel hinauskommen.

Die Fasern enthalten noch viel Oel, allein ihre Menge ist so gering, dass sich die weitere Verarbeitung bei dem bisherigen Umfange eines Palmölwerke unter keinen Umständen lohnen würde. Die Gewinnung dieser absolut genommen nur geringen Mengen von Palmöl kann nur bei ganz grossen Betrieben in Frage kommen und wird dann wahrscheinlich am besten durch ein chemisches Extraktionsverfahren zu lösen sein.

Aus der Entfaserungstrommel kommen die Nüsse in die von aussen geheizte Trockentrommel, welche an die Stelle der früher geübten Trocknung auf einer Zementtenne in der Sonne getreten ist und den Vorzug hat, von der Witterung unabhängig zu sein. Die Trocknung selbst ist unbedingt erforderlich, wenn die Knackmaschine gut arbeiten soll.

Auf dieser von Haake gebauten Maschine werden die Nüsse nunmehr durch Zentrifugalkraft gegen eine gusseiserne runde Wand geschleudert und so geknackt. Schalen und Kerne passieren eine rotierende Siebtrommel, welche die kleinsten Teile entfernt, und fallen dann in ein Salzwasserbad, in welchem die Schalen untersinken, während die Kerne oben schwimmen. Sie werden abgeschöpft und an der Sonne getrocknet.

Neuerdings schlägt die Maschinenfabrik Humboldt vor, dieses Salzwasserbad durch eine sog.Setzmaschine, wie sie im Bergbau üblich ist, zu ersetzen. Die bisherigen Versuche in dieser Richtung sind günstig ausgefallen.

Ein Palmölwerk nach diesem Aguverfahren kostet einschliesslich Lokomobile rund 70,000 M, es verarbeitet bei 10 stündiger Arbeit täglich 8 t. Früchte in Rispen oder 10 t. ausgelesene Früchte. Man gewinnt auf ausgelesene Früchte bezogen in Togo 16 Prozent Palmöl und 10 Prozent Kerne. Das Palmöl hat 5-6 Prozent Fettsäure, höchstens ½ Prozent Schmutz und nur Spuren von Wasser.

Die Betriebskosten lassen sich noch nicht genau überblicken, weil die Fabrik bisher nicht annähernd voll beschäftigt ist, es empfiehlt sich aber nicht, kleinere Typen der einzelnen Maschinen zu nehmen, weil dann die Arbeitsleistung zu gering und daher zu teuer würde. Man wird aber annehmen können, dass das Palmölwerk als solches—also ohne Ernten und Heranbringen der Früchte—mit einer Zahl von 1 Weissen, 1 schwarzen Maschinisten und 15-20 schwarzen Arbeitern im Vollbetriebe auskommt.

Ein Palmöl, wie es die Agupflanzung liefert, ist ohne Zweifel in der Speisefettindustrie, insbesondere der Margarinefabrikation verwendbar, und damit öffnet sich dem Palmöl eine bisher nicht gekannte Verwertungsmöglichkeit grösster Bedeutung. Derartiges Palmöl erzielt schon heute Preise, die 40-50 M über dem aus denselben Früchten gewinnbaren gewöhnlichen Palmöl liegen. Wenn man aber berüchsichtigt, dass bisher nur wenige Fabriken sich für dies Palmöl interessieren, weil es bisher nur in geringen Mengen produziert wird—die Agupflanzung lieferte im letzten Jahre rund 40 t. —so ist wohl mit Sicherheit auf einen wesentlich höheren Mehrpreis in absehbarer Zeit zu rechnen.

Diese Zeit würde um so rascher kommen, je grössere Mengen derartigen Palmöls erzeugt werden.

(*d*) *Vermehrung des Anbaus.*

Die nunmehr gefundene Lösung der Aufgabe einer rentablen maschinellen Verarbeitung der Palmfrüchte hat auch die wichtigste Vorbedingung für eine Vermehrung des Anbaus der Oelpalme geschaffen.

Soweit die Eingeborenen in Betracht kommen, ist jetzt die Möglichkeit gegeben, ihnen die Aufbereitung der Früchte abzunehmen, und dadurch zahlreiche Arbeitskräfte frei zu machen, die dann sich produktiver Tätigkeit, insbesondere auch der Anpflanzung von Oelpalmen, zuwenden könnten.

Man sollte ja meinen, dass die Leute sich geradezu dazu drängen müssten, nur die Palmfrüchte abzuernten und zu verkaufen statt die ganze mühsame Aufbereitung nach ihrer alten Methode durchzuführen. Aber diese Annahme trügt. Der Neger ist viel zu konservativ, er rechnet sich den Preis der in seinem eigenen Betriebe geleisteten Arbeit sehr niedrig oder auch gar nicht, kann man doch z. B. immer wieder beobachten, dass Maismehl nicht teurer ist als die entsprechende Menge von Mais. So ist es für den Europäer auffallend, aber der Denkweise des Negers vollkommen entsprechend, dass die Versuche, Palmfrüchte zu kaufen bisher einen fast völligen Misserfolg bedeuten. Die Anlegung eines Palmölwerkes lediglich zur Verarbeitung aufgekaufter Früchte ist daher vorläufig—wenigstens in Togo und Kamerun-nicht zu empfehlen, es würde auch kein Qualitätspalmöl liefern können, weil man nicht daran denken könnte, Früchte nicht nur in ausreichender Menge, sondern auch von richtigem Reifegrade und sofort nach der Aberntung zu bekommen.

Und doch wird man es anstreben müssen, nach und nach auch die Früchte der Eingeborenen in Palmölwerken zu verarbeiten. Den Uebergang dazu werden diejenigen Palmölwerke bilden, die über so viel eigene Früchte verfügen, um daraus allein rentabel zu sein, deren Leistungsfähigkeit und Verkehrslage ihnen aber zugleich den Ankauf und die Verarbeitung fremder Früchte ermöglicht.

So bildet der europäische Plantagenbetrieb der Oelpalmenkultur eine einstweilen geradezu unerlässliche Vorbedingung der Einrichtung von Palmölwerken und damit der wichtigsten Massnahme zur Ausdehnung auch der Eingeborenenkultur.

Er scheint aber auch an sich recht aussichtsreich, falls er mit ausreichenden Mitteln in geeignetem Klima unternommen wird. Wohl fehlt es noch an exakten Ziffern, wie wir sie für Kokospalmen, Kakao und andere Kulturen haben, dafür bietet sich aber auch noch vielfach die Möglichkeit vorhandene Oelpalmenbestände zu erwerben und in Kultur zu nehmen.

Der europäische Plantagenbau wird dabei die Ausfuhr von Palmöl neben Palmkernen um so wirksamer steigern als bei ihm das gesamte Palmöl-allenfalls bis auf einen kleinen zur Verpflegung der Arbeiter dienenden Teil— zur Ausfuhr gebracht wird. Nimmt man an, dass eine voll tragende Oelpalme jährlich 25 kg. Früchte (auf ausgelesene Früchte umgerechnet) liefert, und dass 1 ha. mit 200 Palmen bepflanzt wird, so erhält man pro ha. 5,000 kg. Früchte oder bei 16 Prozent Ausbringen 800 kg. Palmöl. Demnach würde eine Plantage von 2,600 ha. die bisherige durchschnittliche Ausfuhr von ganz Togo an Palmöl, eine solche von 4,000 ha. diejenige von Kamerun liefern. Man sieht, wie leicht der europäische Plantagenbau eine sehr bedeutende Vermehrung der Palmölausfuhr herbeiführen könnte.

CONTRIBUTION AU PROBLEME DU BUDGET ALIMENTAIRE DE L'ELÆIS.

Calcul des Eléments nutritifs enlevés par les Plantations de Palmiers à Huile.

Par Gaston Williame.

Ce premier essai n'est donné qu'à titre d'indication, vu qu'il ne repose que sur une seule analyse complète d'Elæïs, celle de Zeller, le seul auteur qui se soit essayé à la tâche délicate et fatalement imprécise de fixer le bilan des matières nutritives enlevées par Elæïs. Un travail analogue, établi d'après une méthode sensiblement différente, a été fait par Lépine pour un palmier très voisin, le Cocotier. Sans vouloir discuter à fond les deux méthodes, il y a lieu de remarquer que Lépine, contrairement à Zeller, ne tient pas compte, dans ses calculs, du bouquet de feuilles terminal qui, constamment entretenu par la formation de feuilles nouvelles, immobilise d'une façon permanente, comme le tronc et les racines, une certaine quantité de matières nutritives—et que de son côté Zeller ne tient pas compte de l'âge de l'arbre, et par suite ne fait pas le calcul des matières totales enlevées annuellement et délaisse la question des quantités à restituer chaque année pour l'entretien et le développement du tronc, des racines et du bouquet permanent de feuilles (calculs qui sont donnés en détail pour le cocotier d'après les analyses de Lépine dans " Le Cocotier " de Prudhomme).

Il y aurait un grand intérêt à ce que le travail de Mr. Zeller fût répété en Afrique occidentale et en Malaisie, avec certaines précisions complémentaires. Au lieu de moyennes prises entre des résultats obtenus sur des sols qui, selon le hasard, peuvent être égaux ou différents, et qui ne représentent que des valeurs conventionnelles, il vaudrait mieux donner une analyse aussi complète que possible d'un arbre et de ses produits, ou mieux encore d'une dizaine d'arbres étudiés sur la même parcelle de terre et dont la moyenne représenterait quelque chose de tangible. Ce travail devrait être accompagné de chiffres touchant les conditions de vie de la plante, avec de plus l'analyse du sol sur lequel elle pousse et le rapport entre la composition du sol et celle de l'arbre; ce rapport serait beaucoup plus comparable aux résultats trouvés en d'autres pays que les chiffres actuels. Je sais la difficulté et la caractère un peu aléatoire de pareilles recherches, mais tous les planteurs qui ont besoin de chiffres, pour ne pas aller au hasard, apprécieront l'utilité de celles-ci. Ils pourront arriver à plus d'exactitude s'ils ont le temps et veulent se donner la peine de faire analyser un de leurs propres arbres ainsi que le sol de leur plantation; mais sans doute, de telles recherches et d'autres du même genre ne peuvent être entreprises par les planteurs; elles devraient être l'œuvre d'une station agronomique spéciale pour la culture de l'Elæïs dans le genre de celles qui ont été établies à Java pour la culture de plantes économiques importantes (café, caoutchouc, quinquina, canne à sucre, etc.).[1]

A noter pour la compréhension de mes tableaux, qu'essayant de tirer parti des recherches de M. Zeller, j'ai admis que l'arbre, étudié par lui, pouvait avoir environ 15 ans (par la comparaison du poids de son tronc, qui est de 100 kilos, avec le poids du tronc du cocotier de Lépine, qui était âgé de 30 ans et pesait 180 kilos).

[1] Ce travail venait d'être terminé, lorsque tout dernièrement l'éminent Directeur du Jardin Botanique de Bruxelles, M. De Wildeman, signalait dans *le Bull. de l'Assoc. des Planteurs de Caoutchouc* (1914, p. 103), la création d'une Station expérimentale pour l'Elæïs à Anuradhajuna.

Tableau I.—Composition des Parties d'un Palmier a Huile (pour cent) en Eléments nutritifs principaux.

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
Racines	0·417 (Z.)	0·107 (Z.)	0·515 (Z.)	0·010 (Z.)
Tronc	0·532 (Z.)	0·225 (Z.)	0·249 (Z.)	0·310 (Z.)
Feuilles	1·344 (Z.)	0·142 (Z.)	0·584 (Z.)	0·074 (Z.)
Râfles (Kameroen)	0·420 (Z.)	0·131 (Z.)	1·196 (Z.)	0·144 (Z.)
Râfles (variété Kissédé-Dahomey)	—	0·392 (Lm.)	1·551 (Lm.)	—
Râfles (variété Votchi-Dahomey)	—	0·406 (Lm.)	1·453 (Lm.)	—
Râfles (Guinée) ...	—	0·589 (Lm.)	2·254 (Lm.)	—
Râfles (Sénégal) ...	—	0·466 (Lm.)	0·573 (Lm.)	—
Pulpes (ou résidus des pulpes)	0·924 (Z.) 0·018 (Ho.)	0·408 (Z.) 0·241 (Ho.)	0·426 (Z.) 0·160 (Ho.)	0·645 (Z.) 1·121 (Ho.)
Coques des amandes	0·364 (Z.)	0·115 (Z.)	0·107 (Z.)	0·092 (Z.)
Amandes	1·148 (Z.)	0·781 (Z.)	0·468 (Z.)	0·023 (Z.)
Tourteau (renfermant à peu près tous les éléments minéraux de l'amande) ...	2·40 (M.-G.) 2·5 à 3 (B.-F.)	1·20 (M.-G.) 1·2 à 1·5 (B.-F.)	0·55 (M.-G.) 1·00 (B.-F.)	— —

Origine des Analyses du Tableau précédent (Auteurs ou Rapporteurs) :—

(1) B.-F.—Bussard et Fron, dans "Tourteaux de Graines oléagineuses" (Paris, 1905).

(2) Ho.—Houard, de la Station de Hann, Sénégal. (Analyses rapportées dans "Le Palmier à Huile" (Paris, 1910, Challamel, par J. Adam ; paragraphe de la fumure, p. 106).

(3) Lm.—Lemoigne, Chimiste du Jardin Colonial de Nogent-sur-Marne. (Analyses rapportées dans J. Adam ; paragraphe de la fumure, p. 106).

(4) M.-G.—Muntz et Girard, dans "Les Engrais" (Paris, 1888-91).

(5) Z.—Zeller, du Kamerun, dans "Die Düngungsfrage für die Kultur des Kakao und der Oelpalme in Kamerun" (*Der Tropenpflanzer*, 1911, No. 7, p. 345). Analyse unique mais complète et qui, à défaut d'indication, semble se rapporter à un Elæïs de la variété commune.

Tableau II.—Poids et Nombre moyen des diverses Parties d'un Palmier a Huile.[1]

(Chiffres se rapportant en général à la variété commune.)

Parties de la plante	Poids moyen d'un arbre adulte et de chacune de ses parties	Poids rélatif par rapport au poids du régime	Poids rélatif par rapport au poids des fruits	Nombre moyen des parties de la plante	Poids total annuel moyen des produits de la plante
	Kilos	Pour cent	Pour cent		Kilos
Racines	9·200 (L.)[1]	—	—	—	—
Tronc	100·00 (Z.)	—	—	1	—
Feuilles	6·00 (Z.)... ...	... ...	... ...	20 à 25 terminales (Z.) (1 par mois d'après L. pour cocotier).	— —
Régimes	3·600 (Lm.) ... 3·650 (D.) ... 4·166 (Lr.) ... 4·302 (Ho.) ... 5·000 (Hu.) ... 6·000 (A.) moyenne générale ... 7·275 (E.) ... 11·600 (C.) ... 12·800 (S.) ... 20·000 (M.) ...	... ...	... ...	3 (Z.) ... ... 3·5 (de 1 à 6) (Fr.) ... 5 (A.) pr. Guinée ... 5·5 (de 5 à 6) (Hu.) 10 (A.) pr. Dahomey 11 (de 10 à 12) (E.)	25 à 30 (Hu.) 60 (A.) moyenne générale.
Râfles	2·53 (Z.) ... 3·00 (T.) ...	26 (A.)[2] ... 35 (Hu.-Lr.-C.) 34 à 36 (E.) ... 45·23 (S.) ...	... ...	comme pour les régimes	7·59 (Z.) 8·75 à 10·50 (Hu.) 21·00 (A.) moyenne générale.
Fruits	0·003144 (A.)[2] ... 0·00417 (Fe.) ... 0·00840 (Z.) ...	... ...	... ...	800 (Z.)	11·856 (D.) 16·250 à 19·500 (Hu.) 39·000 (A.) moyenne générale. 100·000 (Ha.) dès la 5e année.

Pulpes (ou résidus de pulpes)	0·000995 (Fe.) ... 0·001428 (A.)[2] ... 0·002800 (Z.) ...	13·312 (C.) ... 17·745 (Lc.) ... 22·735 (S.) ... 28·500 (Hu.) ... 33·603 (A.)[2] ...	20·48 (C.) 27·30 (Lr.) 42·48 (S.) 45·410 (A.)[2]	800 (Z.)	2·680 (Z.) 7·12 à 8·55 (Hu.) 17·710 (A.)[3]
Coques des amandes ...	0·001139 (A.)[2] ... 0·002277 (Fe.) ... 0·004300 (Z.) ...	23 (Hu.) ... 24·095 (S.) ... 26·812 (A.)[2] ... 34·450 (Lr.) ... 36·140 (C.) ...	36·232 (A.)[2] 45·02 (S.) 53·00 (Lr.) 55·60 (C.)	800 (Z.)	5·75 à 6·90 (Hu.) 10·320 (Z.) 14·130 (A.)[3]
Amandes	0·000577 (A.)[2] ... 0·000876 (Fe.) ... 0·001300 (Z.) ...	6·690 (S.) ... 11·180 (Lr.) ... 13·500 (Hu.) ... 13·581 (A.)[2] ... 14·820 (C.) ...	12·50 (S.) 17·20 (Lr.) 18·353 (A.)[2] 22·80 (C.)	800 (Z.)	3·020 (D.) 3·120 (Z.) 3·37 à 4·05 (Hu.) 7·158 (A.)[3] 8 (Hu.) chiffre min. moy. pr. calculs industriels. 10 (Hu.) pr. Côte d'Ivoire. 13·700 (P.) pr. Dahomey. 14·850 (Pr.) pr. Kamerun.
Spathes, inflorescences mâles, inflorescences avortées ...	Les indications à ce sujet n'existent que dans le travail de Lépine pour le cocotier.				
Régimes et fruits tombés avant maturité... ...	Les indications à ce sujet n'existent que dans le travail de Lépine pour le cocotier.				

[1] Les racines n'ayant pas été pesées, et par suite aucun calcul n'ayant été fait par Zeller, nous adoptons ici le chiffre de Lépine pour le cocotier, chiffre qui, dans Lépine, se rapporte à un tronc de 180 kilos et de 30 ans, tandis que l'arbre de Zeller n'a que 100 kilos et un âge indéterminé (âge que nous fixons à 15 ans environ). Néanmoins comme le chiffre de Lépine semble très faible, nous pouvons peut-être l'appliquer à l'Elæïs de Zeller. Le chiffre de Lépine est de 8 kilos ; nous l'avons augmenté de 15 pour cent pour le ramener au poids de substance fraîche (l'analyse de Zeller étant faite sur la substance fraîche) ; nous nous sommes basés pour adopter le chiffre de 15 pour cent sur le pourcentage approximatif d'humidité du tronc étudié par Zeller.

[2] Ces chiffres d'Adam se rapportent à la variété commune du Dahomey (Dê).

[3] Ces chiffres ont été établis en fonction de 60 kilos de régimes et 39 kilos de fruits indiqués plus haut.

Origine des Observations du Tableau II (Auteurs ou Rapporteurs).

(1) (A.).—Adam, dans "La Palmier à Huile" (Paris, 1910, Challamel), paragraphe sur les rendements, page 116, et sur la composition des fruits, page 125.

(2) (C.).—Camayenne (observations faites au Jardin d'Essais de Camayenne, Guinée, et rapportées dans J. Adam).

(3) (D.).—Daniel, du Dahomey (observations rapportées dans J. Adam).

(4) (E.).—Estève, du Dahomey (observations rapportées dans J. Adam).

(5) (Fe.).—Fendler (observations sur l'Elæïs du Togo, rapportées dans le *Bull. of the Imperial Institute*, 1909, No. 4, page 375, d'après *Arbeiten aus den Ph. Inst. Berlin*, 1904, page 189).

(6) (Fr.).—Freyburges, du Togoland (observations rapportées dans J. Adam).

(7) (Ha.).—Hallet, Administrateur-Délégué de Plantations d'Elæïs en Extrême-Orient, dans "Note sur la Question du Palmier à Huile" (Bruxelles, 1912).

(8) (Ho.).—Houard, de la Station de Hann, Sénégal (observations rapportées dans J. Adam).

(9) (Hu.).—Hubert, dans "Le Palmier à Huile" (Paris, 1911, Dunod and Pinat).

(10) (Lm.).—Lemoigne, chimiste du Jardin Colonial de Nogent-sur-Marne (observations rapportées dans J. Adam).

(11) (L.).—Lépine, pharmacien de marine: observations et calculs rapportées dans "All about the Coconut Palm," by Ferguson (Colombo, 1907), et dans "Le Cocotier," par Prudhomme (Paris, 1906, Challamel).

(12) (Lr.).—Leroide, de la Mellacorée, Guinée (observations rapportées dans J. Adam).

(13) (M.).—Maillard (observations rapportées dans J. Adam).

(14) (P.).—Poisson (observations rapportées dans "Le Palmier à Huile," de P. Hubert, page 101).

(15) (Pr.).—Preuss (id., page 101).

(16) (S.).—Savariau, du Dahomey (observations rapportées dans J. Adam).

(17) (T.).—Teissonnier, directeur du Jardin d'Essais de Camayenne, Guinée (observations rapportées dans P. Hubert, page 66).

(18) (Z.).—Zeller, du Kamerun, dans "Die Düngungsfrage für die Kultur des Kakao und der Oelpalme in Kamerun" (*Der Tropenpflanzer*, 1911, No. 7, page 345).

TABLEAU III.—QUANTITES DE MATIERES ENLEVEES PAR UN PALMIER A HUILE (les unes annuellement, les autres en immobilisations permanentes et sans cesse accrues).

Ce Tableau et les suivants ont été établis d'après les Analyses de Zeller et de Lépine.

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Racines (calcul sur 9 kg. 2) ...	0·038	0·0098	0·047	0·0009
Tronc (calcul sur 100 kg.) ...	0·531	0·224	0·249	0·309
Feuilles (calcul sur 120 kg., 20 × 6 kg.)	1·611	0·169	0·699	0·089
Râfles (calcul sur 7 kg. 59, 3 × 2·53 kg.)	0·031	0·007	0·066	0·008
Pulpes (calcul sur 6 kg. 72, 2,400 × 2 gm. 80)	0·060	0·027	0·029	0·043
Coques des Amandes (calcul sur 10 kg. 32, 2,400 × 4 gm. 30)	0·037	0·011	0·011	0·009
Amandes (calcul sur 3 kg. 12, 2,400 × 1 gm. 30)	0·035	0·024	0·014	0·0007

TABLEAU IV.—QUANTITES DE MATIERES ENLEVEES PAR HECTARE (A RAISON DE 125 ARBRES) (les unes annuellement, les autres en immobilisations permanentes et sans cesse accrues).

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Racines	4·750	1·225	5·875	0·1225
Tronc	66·375	28·000	31·125	38·625
Feuilles	201·375	21·125	87·375	11·125
Râfles	3·875	0·875	8·250	1·000
Pulpes	3·125	1·375	1·375	2·125
Coques des Amandes	4·625	1·375	1·375	1·125
Amandes	4·375	3·000	1·750	0·0875
Total	288·500	56·975	137·125	53·210

TABLEAU V.—QUANTITES A RENDRE AU SOL PAR AN ET PAR HECTARE EN RAISON DES IMMOBILISATIONS PERMANENTES (en plus de tous les déchets et résidus de la plantation et des récoltes).

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Racines	4·750	1·225	5·875	0·1225
Tronc	66·375	28·000	31·125	38·625
Feuilles (20 en permanence dans le bouquet terminal)	201·375	21·125	87·375	11·125
Total	272·500	50·360	124·375	49·872
Même total divisé par 15, nombre d'années du palmier	18·166	3·357	8·292	3·325
Même total rectifié selon les idées de Zeller and de Fesca [1]	—	× 5=16·785	× 3=24·876	—
Même total plus un supplément d'un quart pour accroître les rendements	22·708	20·981	31·095	4·156

[1] Les quantités de matières nutritives doivent être, d'après les idées de Fesca et de Zeller, triplées pour la potasse et quintuplées pour l'acide phosphorique, vu les difficultés d'absorption de ces éléments (sous la forme qu'ils affectent généralement dans le sol).

TABLEAU VI.—QUANTITES ENLEVEES PAR LES RECOLTES PAR AN ET PAR HECTARE (et qu'il faudrait rendre sous forme d'engrais, si l'on négligeait de restituer au sol les feuilles et les déchets de fabrication de l'huile de palme : râfles, coques, tourteaux).

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Râfles ...	3·875	0·875	8·250	1·000
Pulpes ...	3·125	1·375	1·375	2·125
Coques des amandes	4·625	1·375	1·375	1·125
Amandes...	4·375	3·000	1·750	0·0875
Total ...	16·000 (correspondant, par arbre, à 0·128)	6·625 (correspondant, par arbre, à 0·053)	12·750 (correspondant, par arbre, à 0·102)	4·3375 (correspondant, par arbre, à 0·035)
Même total rectifié selon les idées de Zeller et de Fesca	—	× 5 = 33·125 (correspondant, par arbre, à 0·265)	× 3 = 38·250 (correspondant, par arbre, à 0·306)	—

TABLEAU VII.—QUANTITES TOTALES A RENDRE AU SOL PAR AN ET PAR HECTARE (en raison des immobilisations et des enlèvements totaux).

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Tronc et racines	71·125	29·225	37·000	38·7475
Même quantité divisée par 15, âge de l'arbre ; pour avoir le chiffre annuel	4·741	1·948	2·466	2·583
Feuilles [1]	120·96	12·78	52·56	6·66
Régimes totaux	16·00	6·625	12·750	4·3375
Total	141·701	21·353	67·776	13·5805
Même total rectifié selon les idées de Zeller et de Fesca	—	× 5 = 106·765	× 3 = 203·328	—
Même total, plus un supplément d'un quart pour accroître les rendements	177·126	133·446	254·160	16·9755

[1] Calcul basé sur 9,000 kilos de feuilles par hectare et par an à raison d'une feuille par mois et 6 kilos par arbre.

Pour le calcul total annuel des éléments enlevés par les feuilles, la méthode de Lépine, qui table sur 1 feuille par mois et par arbre, m'a semblé plus rationnelle que celle qui tablerait sur le nombre de feuilles permanentes et diviserait les quantités trouvées par l'âge des arbres.

Par contre, pour calculer dans le Tableau V les immobilisations par les feuilles, la méthode de Zeller m'a paru la seule convenable.

TABLEAU VIII.—QUANTITES D'ELEMENTS MINERAUX ENLEVES PAR HECTARE ET PAR AN EN ADOPTANT LES MOYENNES D'ADAM.

(Les chiffres d'Adam ne se rapportent qu'au poids des diverses parties des régimes annuellement produits ; pour l'analyse des matières minérales enlevées par le tronc, les racines, etc., nous avons dû nous référer à Zeller : calcul hybride, évidemment non scientifique, et qui n'est donné qu'à défaut d'indications plus précises.)

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Tronc et racines	71·125	29·225	37·000	38·7475
Même quantité divisée par 15, âge de l'arbre, pour avoir le chiffre annuel	4·741	1·948	2·466	2·583
Feuilles[1]	120·96	12·78	52·56	6·66
Total annuel (tronc, racines, feuilles) ...	125·701	14·728	55·026	9·243
Râfles (calcul sur 21 kg.)	0·088 × 125 = 11·000	0·027 × 125 = 3·375	0·251 × 125 = 31·375	0·030 × 125 = 3·750
Pulpes (calcul sur 17·710 kg.)	0·164 × 125 = 20·500	0·072 × 125 = 9·000	0·075 × 125 = 9·375	0·114 × 125 = 14·250
Coques des amandes (calcul sur 14·130 kg.) ...	0·051 × 125 = 6·375	0·016 × 125 = 2·000	0·015 × 125 = 1·875	0·013 × 125 = 1·625
Amandes (calcul sur 7·158 kg.)	0·082 × 125 = 10·250	0·056 × 125 = 7·000	0·033 × 125 = 4·125	0·0016 × 125 = 0·200
Total général	173·826	36·103	101·776	29·068
Rectification selon les idées de Zeller et de Fesca	—	× 5 = 180·515	× 3 = 305·328	—
Même total plus un supplément d'un quart pour accroître les rendements	217·282	225·643	381·660	36·335

[1] Calcul basé sur 9,000 kilos de feuilles par hectare et par an ; une feuille par mois à 6 kilos.

TABLEAU IX.—QUANTITES D'ELEMENTS MINERAUX ENLEVES PAR HECTARE ET PAR AN EN ADOPTANT LES MOYENNES DE A. HALLET.

(Les chiffres de Mr. A. Hallet ne se rapportent qu'au poids des fruits totaux annuellement produits ; pour l'analyse des matières minérales enlevées par le tronc, les racines, etc., nous avons dû nous référer à Zeller : calcul hybride, évidemment non scientifique, et qui n'est donné qu'à défaut d'indications plus précises.)

Parties de la plante	Azote	Acide phosphorique	Potasse	Chaux
	Kilos	Kilos	Kilos	Kilos
Tronc et racines	71·125	29·225	37·000	38·7475
Même quantité divisée par 15, âge de l'arbre, pour avoir le chiffre annuel	4·741	1·948	2·466	2·583
Feuilles[1]	120·96	12·78	52·56	6·66
Total annuel (tronc, racines, feuilles)	125·701	14·728	55·026	9·243
Râfles (calcul sur 35·135 kg.)[2]	0·148 × 125 = 18·500	0·046 × 125 = 5·750	0·420 × 125 = 52·500	0·051 × 125 = 6·375
Pulpes (calcul sur 45·410 kg.)[2]	0·420 × 125 = 52·500	0·185 × 125 = 23·125	0·193 × 125 = 24·125	0·293 × 125 = 36·625
Coques des amandes (calcul sur 36·232 kg.)[2] ...	0·132 × 125 = 16·500	0·042 × 125 = 5·250	0·039 × 125 = 4·875	0·033 × 125 = 4·125
Amandes (calcul sur 18·353 kg.)[2]	0·211 × 125 = 26·375	0·143 × 125 = 18·125	0·086 × 125 = 10·750	0·004 × 125 = 0·500
Total général	239·576	66·978	147·276	56·868
Rectification selon les idées de Zeller et de Fesca	—	× 5 = 334·890	× 3 = 441·728	—
Même total plus un supplément d'un quart pour accroître les rendements	299·470	418·612	552·160	71·085

[1] Calcul basé sur 9,000 kilos de feuilles par hectare et par an ; une feuille par mois à 6 kilos.

[2] Obtenus en fonction des poids relatifs cités par Adam pour le Dê (variété commune du Dâhomey), rapportés au poids total des fruits donné par A. Hallet (voir Table II) ; on signale en effet l'Elæïs de Melaisie comme appartenant à la variété ordinaire, ce qui justifie le calcul précédent.

COCONUT PLANTATIONS IN THE INTERIOR OF AFRICA.

By Professor Edm. Leplae.

Director-General of Agriculture, Colonial Office, Brussels.

It is a common belief that the coconut palm flourishes only in close proximity to the sea-shore. From particulars gathered in Central Africa and Brazil, it appears that this tree thrives quite as well, if planted in suitable soils and climates, even at a very great distance from the sea, and in continental situations.

Coconut plantations in the interior of Belgian Congo are as yet represented only by small clumps or avenues of coconut palms in a few places on the river in Central Congo. The growth of these palms, however, although planted at a distance of 550 miles from the sea, as at the Eala Botanical Gardens, and at 970 miles, as at Stanleyville, is quite satisfactory on account, no doubt, of the permanent and warm moisture and the regularly misty nights.

The annual rainfall on the northern reach of the river varies between 52 and 80 in., the average being about 64 in. (1,600 mm.). On the lower Aruwimi River the average is near 80 in.

Average Rainfall in Upper Congo.

Eala Botanical Gardens ...	Average of 2 years	1961·9 m/m.	77·13 in.
Barumbu cocoa plantation	,, 2 ,,	1650·0 ,,	66·35 ,,
Yangambi rubber plantation	,, 2 ,,	1417·5 ,,	55·75 ,,
Gazi ,, ,,	,, 3 ,,	1960·0 ,,	77·16 ,,
Stanleyville	,, 2 ,,	1674·0 ,,	65·21 ,,
Lula coffee plantation ...	,, 2 ,,	1807·5 ,,	71·16 ,,

The rainfall in these places is fairly well distributed throughout the year, as is indicated in the following table, and there are no real dry seasons.

	Eala.		Yangambi.		Lula.	
	M/m.	Inches.	M/m.	Inches.	M/m.	Inches.
January	70·95	2·79	68·7	2·70	61·6	2·42
February ...	217·8	8·57	80·5	3·17	128·0	5·04
March	138·7	5·46	97·15	3·82	151·75	5·98
April	100·1	3·94	172·0	6·77	247·9	9·76
May	177·5	6·99	152·5	6·00	121·45	4·78
June	128·9	5·07	84·95	3·34	107·75	4·24
July	104·95	4·13	71·35	2·81	145·15	5·71
August	124·2	4·89	67·20	2·64	185·45	7·30
September ...	231·6	9·11	169·45	6·67	185·65	7·31
October... ...	285·1	11·22	195·40	7·70	200·15	7·88
November ...	258·95	10·11	183·80	7·20	202·15	7·96
December ...	123·15	4·85	74·55	2·93	70·55	2·78
	1,961·90	77·13	1,417·55	55·75	1,807·55	71·16

The average temperature is 25·20° C. (77·36° F.), the lowest temperature on record being 20·25° C. (68·45° F.), and the highest 38·7° C. (101·66° F.); the average humidity of the air is 85 per cent. Heavy mists occur nearly every night and the dew drips freely from leaves and twigs every morning.

Several varieties of coconut palms were imported from Java, Singapore and Colombo, and show excellent growth at the Eala Botanical Gardens. The following are some of the varieties which are cultivated:—

Planted in 1900:

1 *Cocos nucifera* var. *incarnata*.
1 *C. nucifera* var. *macrocarpa*.
7 *C. nucifera* var. *viridis*.

Planted in 1903:

200 Cocos from Boma.

Planted in 1910:

4 *Cocos nucifera* var. Ambon.
3 *C. nucifera dioica* var. Aren Idjo.
3 *C. nucifera* var. Aren Merah.
2 *C. nucifera macrocarpa* Klappa Bali.
2 *C. nucifera microcarpa* var. Ginja.

2 *C. nucifera oblonga* Klappa Gohtjoh.
1 *C. nucifera pubescens* Klappa Merah.
2 *C. nucifera stuposa* Klappa Boöl.
1 *C. nucifera eburnea* Klappa Gadiang.
2 *C. nucifera subglobosa* Klappa Djepoen.
2 *C. nucifera subglobosa* Klappa Besar.
2 *C. nucifera viridis* Klappa Idjo.
3 *C. nucifera* Klappa Matahari Besar.
1 *C. nucifera* Klappa Parang Idjo.
1 *C. nucifera angustifolia* Klappa Pinang.
2 *C. nucifera* Klappa Tandoek.
2 *C. nucifera* Klappa Tikeh Merah.
3 *C. nucifera* Klappa Tikeh Idjo.
2 *C. nucifera* Klappa Parang.

Planted in 1913:

5 *Cocos nucifera* Klappa Merah.
4 *C. nucifera* Klappa Idjo.
8 *C. nucifera* Klappa King coconut.

The results of the experiments show that the production of copra is possible in the central part of the Belgian Congo, and the Government is about to start a plantation of a few hundred acres near Yangambi. A well-known copra expert, who travelled recently through Central Congo, considers that there is a great future for coconut plantation in the Equatorial part of Congo. Extensive tracts of suitable land occur which may be leased or bought cheaply from the Government, whilst plenty of native labour is to be found at about 2½d. a day.

Large coconut plantations could also be established, combined with cattle raising, round the Tumba or Leopold Lakes and on the natural meadow land extending between the Kasai and N'Fini Rivers, opposite the Government Rubber Plantations of Bokala. The rainfall is neither so heavy nor so regular here as on the Equator, but it averages 52 in. and plenty of land can be selected where underground moisture is always abundant, without any excess. The rainfall at Bokala throughout the year is shown in the following table:—

	M/m.	Inches.
January	47·8	1·88
February	225·0	8·86
March	90·5	3·56
April	93·5	3·68
May	150·3	5·92
June	30·6	1·20
July	0·0	0·0
August	24·5	0·96
September	82·6	3·21
October...	267·4	10·52
November	135·7	5·34
December	62·6	2·46

We have received from the White Fathers at Antwerp photographs taken recently in the Mission Gardens at Beauduinville and Mpala, on Lake Tanganyika and at Tabora (German East Africa). These pictures show young and full-grown coconut palms that are in the most excellent conditions of growth. Those at Tabora yield heavily.

RICERCHE SULLE FORME COLTURALI DI OLIVO DELLA TRIPOLITANIA.

Per il Dott. Oberto Manetti.

Vice Direttore dell'Istituto Agricolo Coloniale Italiano di Firenze.

La Tripolitania è il paese dove l'olivo cresce rigogliosamente dovunque e dove la coltura dell'albero *sacro a Minerva* è tenuta dagli indigeni ancora oggi in altissimo conto. Si può anzi dire che in Tripolitania l'olivo è la specie arborea più coltivata, dopo la palma da datteri. Ma dove la mancanza e la deficenza di acqua irrigua impedisce la coltivazione della palma, l'olivo acquista una importanza grandissima, essendo coltivato su larga scala (*gran coltura asciutta*) sia in boschi di olivi specializzati, sia consociato alle cereali, specialmente coll'orzo.

Nelle associazioni dei giardini ed orti irrigui della costa (le cosiddette oasi di Tripoli, Tagiura, Zanzur, Sliten, ecc.) l'olivo si trova coltivato promiscuamente alle palme ed a numerosi altri alberi da frutto; le cure che si hanno all'olivo in queste regioni sono però minori ed inferiori a quelle che invece si praticano per gli olivi dell'altopiano retrostante (*gebèl*), dove le olivete prosperano con la sola coltura asciutta.

Sono note le foreste di olivi (*gaba zeitùn*) dello Msellata e del Carian, dove le piante, spesso secolari, raggiungono delle proporzioni gigantesche e danno prodotti veramente ragguardevoli. Nelle due regioni soprannominate, e che appartengono all'altipiano Tripolitano, il sottoscritto ha raccolto i campioni delle forme colturali di olivo coltivate dagli indigeni ed il presente lavoro è una breve esposizione delle ricerche effettuate nei campioni stessi nel Laboratorio Chimico Agrario dell'Istituto Agricolo Coloniale Italiano di Firenze.[1]

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[1] Le olive studiate facevano parte del materiale raccolto dalla Missione Franchetti in Tripolitania, inviata nella nuova colonia Mediterranea Italiana dalla Società per lo Studio della Libia a compiervi ricerche di tecnica e di economia agraria. *v.* " Missione Franchetti in Tripolitania," Fratelli Treves editori Milano, 1914, Vol. I.

Le forme colturali che sono state studiate sono le seguenti, che riportiamo secondo la denominazione originale degli indigeni.

Msellata.

(1) Bed hamàm, (2) Bèsri, (3) Endùri, (4) Faggùsi, (5) Farcùti, (6) Gheddàni, (7) Ghelb sardùc, (8) Giabbùgi, (9) Ghergàsci, (10) Iudi, (11) Limi, (12) Mammùdi, (13) Marràri, (14) Mongàr agèl, (15) Nbutì, (16) Neb gemèl, (17) Rasli, (18) Rumi, (19) Safràni, (20) Scemlàli, (21) Srasi, (22) Suabà arùss, (23) Tuàl malìg.

Garian.

(1) Gherràsi, (2) Crusi, (3) Ghanìmi.

Naturalmente le denominazioni riportate possono benissimo non corrispondere ad altrettante varietà, ma essere piuttosto forme diverse delle stesse razze coltivate. E noto infatti che anche in Tunisia il Minangoin, il Kearney ed il Marcille nei loro noti lavori hanno trovato omonimie e sinonimie nelle razze coltivate nel Sahel di Sfax, che non sempre possono essere da noi accettate.

Nella presente comunicazione, dato lo scarso materiale che abbiamo potuto fino ad oggi studiare, non si è neppure tentato un lavoro di sintesi e di critica per quello che riguarda la specificazione delle razze di olive coltivate nell'altipiano della Tripolitania.

Abbiamo invece esaminate le forme coltivate, analizzandole soprattutto rispetto a tre caratteri fondamentali; il *portamento delle piante, la lunghezza delle foglie, e le caratteristiche morfologiche e chimiche principali dei frutti.*

I dati che seguono sono infatti esclusivamente riferiti ai caratteri sopraindicati. Gli studi ulteriori, sia che siano effettuati con più lunghi sopraluoghi, sia con ricerche di laboratorio su campioni più abbondanti e con vero "materiale critico," potranno condurre a delle più precise nozioni circa la caratterizzazione delle varietà di olivo indigene, coltivate in Tripolitania.

Fino a che questi studi non saranno seriamente eseguiti, crediamo che le ricerche da noi effettuate ed i dati che riportiamo potranno però costituire un primo contributo alla conoscenza della olivicoltura Tripolitania.

Portamento delle piante.

Una classificazione anche provvisoria basata sul portamento, dell'apparecchio vegetativo degli olivi non può certamente essere presa in seria considerazione. Tutti gli olivi dello Msellata, come portamento generale della pianta, si rassomigliano estremamente; solo una grande pratica, come la possono avere i coltivatori indigeni, può servire a distinguere una forma dall'altra. Ed anzi spesso avviene che anche i più pratici dei nativisiano incerti a stabilire quale denominazione precisa dare ad un olivo, senza che questo non abbia foglie giovani e frutti.

Ad ogni modo abbiamo trovato esemplaro di un portamento maestoso, che fa rammentare quello delle nostre grosse quercie, in molti individui delle forme denominate *nbuti*, *rumi*, *srasi*, *scemlàli*, *marràri*, *neb gemèl*, *rasli*, *gherràsi* e *crusi*.

Pare invece che siano riconoscibili al portamento sensibilmente meno imponente e più rassomigliante a quello degli olivi comuni della Liguria e della Toscana le forme dette *iudi*, *faggùsi*, *ghanìmi*.

Gli stessi indigeni però non danno alcuna importanza al portamento della pianta, dichiarando essi che la stessa razza o meglio gli olivi della stessa denominazione sogliono cambiare portamento a seconda del luogo, più o meno favorevole, in cui sono stati piantati. L'acqua di scorrimento degli impluvi (largamente adoperata dai coltivatori indigeni) e l'umidità del suolo, specialmente contribuiscono a dare alle piante un portamento più rigoglioso ed una statura più grande.

Dimensioni delle foglie.

Nella tabella seguente abbiamo ottenuti sui resultati di misurazioni eseguite sui picciuoli e sulle lamine delle foglie medie dei rami più giovani.

Le ricerche sono state eseguite su campioni da erbario di olivi raccolti nello Msellata.

Le foglie di maggiore dimensione e che anche a prima

TABELLA I.

Nome della forma coltivata	Lunghezze medie dei piccioli m/m	Lamine foglie medie	
		Lunghezza lungo la nervatura principale m/m	Lunghezza massima m/m
Msellata.			
1. Bed hamàm ...	—	—	—
2. Bèsri	5-8	50-60	12-13
3. Endùri	3-5	50-55	8-10
4. Faggùsi	3-4	45-55	8-9
5. Farcùti	4-5	45	10-11
6. Gheddàni ...	3-4	55-65	12-13
7. Ghelb sardùc ...	2-3	40-45	7-8
8. Giabbùgi	3-4	45-50	8-9
9. Ghergàsci ...	3	40-45	7-8
10. Iudi	3-4	40-45	9-10
11. Limi	3-4	55-65	10-13
12. Mammùdi ...	4-5	45-50	9-11
13. Marràri	5	50-65	11-12
14. Mongàr agèl ...	5-6	55-60	9-10
15. Nbuti	5-6	50-70	13-20
16. Neb gemèl ...	6-8	60-65	9-10
17. Rasli	3-5	45-50	10-11
18. Rumi	5	60-65	14-15
19. Safràni	3	45-50	9-10
20. Scemlàli	3-4	40-50	8-9
21. Srasi	3	40-50	8-9
22. Suabà arùss ...	4-5	55-60	8-9
23. Tuàl malìg ...	4-5	40-50	8-10
Garian.			
1. Gherràsi	—	—	—
2. Crusi	—	—	—
3. Ghanìmi	—	—	—

vista appaiono cali—sono quelle degli olivi *rumi* e *nbuti;* quelle invece che sono evidentemente più piccole appartengono agli ulivi tipo *neb gemèl ghelb, sardùc* e *ghergàsci.*

Si può dire ad ogni modo che le foglie di olivo raggiungono in media una lunghezza lungo l'asse (escluso il picciolo) di 45-50 mm., ed una larghezza massima di circa 9-10 mm. Le pagine fogliari delle foglie degli olivi Tripolini non sono quindi sensibilmente minori in dimensioni di quelle degli olivi dell'Europa Meridionale; ciò che sta quindi a denotarci il fatto che gli olivi coltivati localmente non hanno avuto affatto bisogno di adottare delle disposizioni morfologiche, atte a resistere in modo particolare all'ambiente spiccatamente più secco dell'altopiano Tripolitano. E per converso ciò dimostra anche che l'olivo in Tripolitania non ha bisogno di speciali adattamenti per prosperare.

Ricerche sui frutti.

Le ricerche sulle olive sono le più importanti, non solo perchè queste rappresentano il prodotto principale per cui la pianta è coltivata; ma anche perchè oggi tende realmente a prevalere tra gli studiosi di olivicoltura l'idea che le razze di olivo debbono essere classificate, sotto il punto di vista economico, specialmente a seconda dei caratteri morfologici e chimici delle olive.[1] Un interessante contributo allo studio delle forme colturali dell'olivo in Tripolitania sarebbe stato fornito dalla conoscenza del raccolto medio in olive per piede, in fase di regime della pianta, prendendo a considerare i piedi di ciascuna forma colturale separatamente. Allo stato attuale delle nostre conoscenze agricole sulla Tripolitania, non potremmo peraltro seriamente concludere in proposito, mancandoci non solo i dati sperimentalmente rigorosi (che sono l'unica fonte scientifica di tali ricerche), ma risultando contradditorie anche le stesse informazioni degli indigeni; i quali non si dànno certo a cercare quale carica precisa o mediamente costante possa raggiungere una forma colturale piuttosto che un'altra.

Dati sul raccolto degli olivi tripolitani sono stati radunati dalle recenti Commissioni Tecniche[2] che hanno percorso il paese e lo hanno esplorato dal punto di vista agricolo; ma i risultati delle inchieste sono troppo vaghi perchè si possano ritenere come definitivi. Ad ogni modo trattasi sempre di notizie fornite dagli indigeni e mai di esperienze dirette, anche di semplici coltivatori europei.

Ciò posto, le nostre indagini si sono applicate specialmente alla ricerca:—

1º *del peso assoluto e relativo delle olive.*

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[1] V. ad es. I. Ruby, "Contribution à l'étude de variétés d'olives tunisiennes," in *L'Agriculture Pratique des Pays Chauds*, No. 124, 13me année, Juillet, 1913.

[2] V. *Missione Agrologica Governativa* del Ministero delle Colonie, vol. II, pag. 213, e *Missione Franchetti in Tripolitania*, vol. I, pag. 442.

2° *del rapporto in peso tra la polpa e il nocciolo delle olive.*

3° *del diametri (maggiore = D, e minore = d) delle olive e del rapporto D/d, per ogni forma coltivata.*

4° *dell'umidità e della sostanza grassa greggia delle olive.*

Nella seguente tabella No. 2 sono riferiti i resultati di cui al comma 1 e 2, che precedono; nella tabella No. 3 sono riportati i dati relativi alle indagini indicate nel comma No. 3; e finalmente nell'ultima tabella No. 4 sono segnate le cifre che riguardano le ricerche di ordine chimico nella polpa delle olive ed elencate nel comma 4. Il non abbondante materiale a disposizione ha impedito di estrarre la materia grassa delle olive col comune torchio da laboratorio, il cui uso certo più che ogni altro apparecchio analitico si sarebbe avvicinato alla pressa da olio, usata anche dai coltivatori arabi (benchè in modo assai primitivo) per ottenere l'olio detto *zeit masri;* che costituisce poi la qualità d'olio principale e più comune in Tripolitania. Abbiamo quindi sottoposto la *polpa seccà* di olive all'estrattore di Soxlet, togliendo poi all'" estratto etereo greggio " le " sostanze non saponificabili " per ottenere quello che abbiamo precedentemente chiamato " sostanza grassa greggia " delle olive.

Dall'esame delle tabelle sopra riportate risulta evidente che non poche delle forme colturali degli olivi indigeni coltivati in Tripolitania hanno certamente una importantanza notevole rispetto al loro prodotto e possono essere suscettibili di un avvenire sicuro.

Anche in confronto colle nostre più comuni razze coltivate in Italia, alcune delle forme colturali Tripolitane studiate rappresentano sempre un considerevole valore, tale per lo meno da potersi fino ad oggi affermare la necessità di eseguire sperimentalmente delle prove razionali di coltura colle migliori varietà coltivate indigene.[1]

Si noti anche che i valori relativi all'umidità delle polpe di oliva variano moltissimo, e cioè da un minimo del

[1] Le razze indigene di olivo sono anche precocissime per il loro prodotto rispetto alle forme di olivo coltivate in Italia: questo vantaggio notevole non dovrà certamente essere trascurato.

Tabella II.

Peso assoluto e relativo delle olive—Rapporto $\frac{\text{polpa}}{\text{nocciolo}}$

Forme colturali	Peso medio di un oliva gr.	Peso medio di un nocciolo gr.	Peso medio della polpa di 1 oliva gr.	Peso medio di 100 olive gr.	Peso medio di 100 noccioli gr.	Peso medio della polpa di 100 olive gr.	Rapporto $\frac{\text{polpa}}{\text{nocciolo}}$ polpa = 100
Msellata.							%
1. Bed hamàm	2·0450	0·6948	1·3501	204·500	69·488	135·012	51·463
2. Bèsri	1·0715	0·3706	0·7009	107·154	37·060	70·094	52·874
3. Endùri	1·8722	0·6342	1·2380	187·228	63·420	123·808	51·228
4. Faggùsi	1·5916	0·9674	0·6242	159·168	96·748	62·420	156·584
5. Farcùti	1·4771	0·5004	0·9767	147·710	50·040	97·670	51·233
6. Gheddàni	1·2576	0·4903	0·7673	125·760	49·030	76·730	63·899
7. Ghelb sardùc	1·8840	0·5336	1·3504	188·400	53·360	135·040	39·514
8. Giabbùgi	1·1297	0·4560	0·6737	112·976	45·600	67·376	67·680
9. Ghergàsci	0·6197	0·2450	0·3746	61·976	24·508	37·468	65·40
10. Iudi	1·1266	0·5480	0·5786	112·660	54·800	57·860	97·41
11. Limi	2·1586	0·4944	1·6642	215·860	49·440	166·420	29·707
12. Mammùdi	1·1666	0·5052	0·6614	116·668	50·520	66·148	76·38
13. Marràri...	1·6422	0·4601	1·1821	164·220	46·010	118·210	38·92
14. Mongàr agèl	1·5780	0·5941	0·9839	157·800	59·410	98·390	60·38
15. Nbuti	1·6062	0·5701	1·0367	160·620	57·010	103·610	54·98
16. Neb gemèl	2·0651	0·8429	9·2222	206·510	84·290	122·220	68·97
17. Rasli	1·0270	0·3976	0·6294	102·700	39·760	62·940	63·17
18. Rumi	1·7511	0·4708	1·2803	175·112	47·080	128·032	36·78
19. Safràni	2·1261	0·4777	1·6484	212·610	47·770	164·840	28·98
20. Scemlàli	0·9896	0·3166	0·6730	98·960	31·660	67·300	47·04
21. Srasi	1·9409	0·4320	1·5089	194·090	43·200	150·890	28·63
22. Suabà arùss	2·3327	0·8077	1·5250	233·276	80·770	152·503	52·96
23. Tuàl malìg	1·0334	0·3576	0·6758	103·340	35·760	67·580	52·92
Garian.							
1. Gherràsi	1·7294	0·5590	1·1703	172·940	55·900	117·030	47·78
2. Crusi	1·1145	0·3267	0·7878	111·450	32·670	78·780	41·47
3. Ghanìmi	0·8762	0·2968	0·5793	87·620	29·680	57·930	51·23

TABELLA III.

DIAMETRI (MAGGIORE E MINORE) DELLE OLIVE TRIPOLITANE.

Forme colturali	Diametro maggiore medio mm.		Diametro minore medio mm.		Rapporto medio Diametro maggiore / Diametro minore		Rapporto	
	Oliva	Nocciolo	Oliva	Noccioli	Oliva	Nocciolo	Diametro magg. oliva / nocciolo	Diametro minore oliva / nocciolo
Msellata.								
1. Bed hamàm	23·17	15·80	17· 2	10·00	1·345	1·580	1·466	1·722
2. Bèsri	20·77	17·70	12·77	7·30	1·626	2·425	1·173	1·749
3. Endùri	25·05	19·00	16·22	8·90	1·544	2·135	1·318	1·822
4. Faggùsi	23·66	19·00	15·83	9·00	1·495	2·111	1·245	1·758
5. Farcùti	24·83	19·40	14·94	7·90	1·662	2·456	1·280	1·891
6. Gheddàni	15·05	20·20	15·33	7·40	1·634	2·730	1·240	2·072
7. Ghelb sardùc	23·22	17·20	14·94	8·70	1·554	1·973	1·350	1·717
8. Giabbùgi	25·28	19·90	15·00	7·60	1·685	2·619	1·270	1·974
9. Ghergàsci	18·31	14·60	11·77	6·90	1·556	2·116	1·254	1·705
10. Iudi	25·00	15·90	14·96	8·70	1·671	1·828	1·572	1·720
11. Limi	22·11	14·00	17·77	8·90	1·244	1·573	1·579	1·997
12. Mammùdi	22·55	19·10	12·88	8·00	1·751	2·238	1·181	1·610
13. Marràri	22·39	17·50	14·88	8·80	1·505	1·989	1·280	1·691
14. Mongàr agèl	22·72	18·00	15·66	9·00	1·451	2·000	1·262	1·740
15. Nbuti	21·81	16·00	15·77	8·80	1·383	1·818	1·363	1·792
16. Neb gemèl	28·33	22·20	17·27	9·40	1·640	2·362	1·276	1·837
17. Rasli	20·39	15·90	13·05	8·10	1·563	1·963	1·283	1·611
18. Rumi	22·65	14·00	17·65	8·80	1·283	1·591	1·618	2·005
19. Safràni	23·00	14·80	17·92	8·50	1·283	1·741	1·554	2·108
20. Scemlàli	19·45	13·80	14·03	8·00	1·397	1·725	1·410	1·753
21. Srasi	21·88	13·80	18·47	8·80	1·185	1·568	1·586	2·099
22. Suabà arùss	25·22	20·30	15·94	9·50	1·582	2·173	1·242	1·678
23. Tuàl malìg	23·17	17·70	13·88	8·50	1·67	2·082	1·309	1·633
Garian.								
1. Gherràsi	17·20	13·88	13·43	7·78	1·281	1·784	1·239	1·726
2. Crusi...	18·93	15·50	11·07	6·71	1·710	2·310	1·221	1·650
3. Ghanìmi	17·30	12·60	9·88	7·00	1·747	1·800	1·373	1·411

TABELLA IV.

UMIDITA E SOSTANZA GRASSA GREGGIA NELLA POLPA DELLE OLIVE TRIPOLITANE.

Forme culturali	Umidità	Sostanza secca	Estratto etereo greggio Per cento di sostanza secca	Sostanze non saponificabili		Sostanza grassa greggia	
				Per cento di estratto etereo	Per cento di sostanza secca	Per cento di sostanza secca	Per cento di sostanza originaria
Msellata.							
1. Bed hamàm	11·08	88·92	31·95	6·35	19·87	29·92	26·60
2. Bèsri	19·70	80·30	17·08	6·69	39·16	15·93	12·79
3. Endùri	15·72	84·28	30·05	3·99	13·27	28·85	24·31
4. Faggùsi	19·22	80·78	49·31	5·41	10·97	46·64	31·67
5. Farcùti	13·12	86·88	21·88	3·97	18·14	21·01	18·25
6. Gheddàni	20·71	79·29	29·47	3·65	12·38	28·48	22·58
7. Ghelb sardùc	25·37	74·63	25·64	2·87	11·19	24·90	18·58
8. Giabbùgi	12·85	87·15	33·89	3·55	10·47	32·68	28·48
9. Ghergásci	21·72	78·28	26·78	4·67	17·43	32·63	25·54
10. Iudi	42·11	57·89	21·34	5·41	25·35	20·18	11·68
11. Limi	39·85	60·15	20·05	4·12	20·54	19·22	11·56
12. Mammùdi	33·54	66·46	40·22	5·09	12·65	38·17	25·36
13. Marràri	10·26	89·74	25·94	3·46	13·34	25·04	22·47
14. Mongàr agèl	20·62	79·38	36·21	5·05	13·94	34·38	27·29
15. Nbuti	30·28	69·72	31·95	6·35	19 88	29·92	20·86
16. Neb gemèl	12·16	87·84	15·91	2·06	12·94	15·58	13·68
17. Rasli	21·40	78·60	36·42	8·69	23·86	33·25	26·13
18. Rumi	59·15	40·85	17·01	4·38	25·74	16·23	6·63
19. Safràni	11·60	88·40	35·44	4·50	12·69	33·84	29·91
20. Scemlàli	46·54	53·46	22·33	5·28	23 64	21·15	11·30
21. Srasi	48·11	51·89	17·00	1·57	9·23	16·73	8·68
22. Suabà arùss	26·82	73·18	33·34	4·79	14·36	31·74	23·22
23. Tuàl malìg	18·92	81·08	18·59	3·60	19·36	17·82	14·44
Garian.							
1. Gherràsi	59·75	40·25	47·95	2·25	4·69	46·87	18·86
2. Crusi	53·83	46·17	32·08	2·52	7·85	31·27	14·43
3. Ghanìmi	57·64	42·36	35·16	3·15	8·95	34·05	14·42

10·26 per cento ad un massimo di 59·75 per cento. Questa straordinaria variozione, che le nostre ricerche hanno rilevato, e che si ripercuote poi nella composizione generale del materiale analizzato, in parte può essere giustificata dal variare della quantità di acqua di vegetazione contenuta nelle olive, prodotte da piante situate in un terreno più ricco di umidità rispetto a quelle cresciute in un suolo più secco.

In questo caso le olive provenienti dal Carian si troverebbero quindi a rappresentare i prodotti di una zona migliore di quella dello Msellata. Non crediamo però di poter generalizzare queste affermazioni, che solo possono avere un carattere scientifico di veridicità quando sieno fatte dopo un numero rilevante e ripetuto di analisi, eseguite sul posto e su olive, raccolte in diversi anni ed in diversi momenti del periodo di maturazione. Il certo si è che anche la semplice costatazione delle variazioni del contenuto in acqua nella polpa delle olive tripolitane deve farci procedere assai cauti nell'apprezzamento della quantità di "sostanza grassa greggia" che i singoli campioni hanno dimostrato di provvedere all'analisi.

Si pensi anche—e ciò ancor più contribuisce a dare ai dati rilevati ed esposti un carattare di relatività—che le determinazioni furono eseguite su campioni giunti in Italia dalla Colonia e prelevati quando il raccolto dagli indigeni non era ancor giudicato propizio; poichè gli esemplari di olive ci son giunti uniti ai rametti stessi delle piante, come noi stessi avevamo richiesto per potere avere la sicurezza che le olive delle forme colturali ricercate corrispondevano veramente a quelle che noi volevamo e che già possedevamo in campioni da erbario.

Molte delle olive, appartenenti al materiale studiato, quantunque giunte in perfetto stato di imballaggio, erano però leggermente avvizzite.

Tutte queste considerazioni ci portano quindi a concludere che i nostri studi sulle forme colturali delle olive tripolitane sono tutt'altro che definitivi; che anzi la relatività stessa delle conclusioni a cui giungiamo non può servire ad altro che a disporre in una graduatoria—che riteniamo assai esatta—le forme colturali di olivo studiate a seconda dell'importanza che queste possono assumere in base ai caratteri studiati.

Tabella V.

Classificazione delle olive Tripolitane in base alle ricerche gia esposte.

No. d'ordine	Secondo il maggior volume delle olive			Secondo il maggior peso delle olive				Secondo la percentuale della "Sostanza grassa greggia," delle olive		
	Nome indigeno	Diametri		Nome indigeno	Peso di 100 olive			Nome indigeno	Grassi greggi	
		D	d		Olive intere	Nocciolo	Polpa		Per cento di polpa	Per cento di olive intere
1	Neb gemèl ...	28·33	17·17	Suabà arùss ...	223·27	80·170	152·503	Safràni	29·91	23·189
2	Giabbùgi	25·28	15·00	Limi	215·86	49·440	166·420	Mongar agèl ...	27·29	17·015
3	Suabà arùss ...	25·22	15·94	Safràni	212·61	47·470	164·840	Giabbùgi	28·48	16·984
4	Endùri	25·05	16·22	Neb gemèl ...	206·51	34·290	122·220	Marràri	22·47	16·174
5	Gheddàni	25·05	15·33	Bed hamàm ...	204·50	69·48	135·012	Endùri	24·31	16·075
6	Iudi	25·00	14·96	Srasi	194·09	43·200	153·890	Rasli	26·13	16·013
7	Farcùti	24·83	19·40	Ghelb sardùc ...	188·40	53·360	135·040	Ghergàsci... ...	25·54	15·440
8	Faggùsi	23·66	15·83	Endùri	187·23	63·420	123·808	Suabà arùss ...	23·22	15·179
9	Ghelb sardùc ...	23·22	14·94	Rumi	175·11	47·770	164·840	Faggùsi	37·67	14·770
10	Tuàl malìg ...	23·17	13·88	Gherràsi	172·94	55·900	117·030	Mammùdi ...	25·36	14·378
11	Bed hamàm ...	23·17	17·22	Marràri	164·22	46·010	118·210	Bed hamàm ...	26·60	14·260
12	Safràni	23·00	17·92	Nbuti	160·62	57·010	103·610	Gheddàni ...	22·58	13·772
13	Mongar agèl ...	22·72	15·66	Faggùsi	159·16	96·748	62·420	Nbuti	20·86	13·456
14	Rumi	22·65	17·65	Mongàr agèl ...	157·80	59·410	98·390	Ghelb sardùc ...	18·58	13·317
15	Mammùdi ...	22·55	12·88	Farcùti	147·76	50·040	97·670	Gherràsi	18·86	12·762
16	Marràri	22·39	14·88	Gheddàni	125·76	49·030	76·730	Farcùti	18·25	12·070
17	Limi	22·11	17·77	Mammùdi... ...	116·67	50·520	66·148	Crusi	14·43	12·200
18	Srasi	21·88	18·47	Giabbùgi	112·97	45·600	67·376	Ghanìmi	14·42	9·533
19	Nbuti	21·81	15·77	Iudi	112·66	54·800	57·860	Tuàl malìg ...	14·44	9·433
20	Bèsri	20·77	12·77	Crusi	111·45	32·670	78·780	Limi	11·56	8·912
21	Rasli	20·39	13·05	Bèsri	107·15	37·060	70·094	Bèsri	12·79	8·366
22	Scemlàli	19·46	14·03	Tuàl malìg ...	103·34	35·760	67·580	Neb gemèl ...	13·68	8·096
23	Crusi	18·93	11·07	Rasli	102·70	39·760	62·940	Scemlàli	11·30	7·685
24	Ghergàsci... ...	18·31	11·77	Scemlàli	98·96	31·660	67·300	Srasi	8·68	6·748
25	Gherràsi	17·20	13·43	Ghanìmi	87·62	29·680	57·930	Iudi	11·68	5·998
26	Ghanìmi	17·30	9·88	Ghergàsci... ...	61·976	24·508	39·468	Rumi	6·63	4·840

Spetta alla sperimentazione avvenire, fatta sul posto con materiali seriamente raccolti successivamente per più anni, e per le stesse piante studiati, a dire l'ultima e decisiva parola sul valore delle olive coltivate dagli indigeni in Tripolitania. Si potrà allora anche prendere in considerazione i caratteri morfologici del nocciolo e quelli dell'oliva nel loro complesso, nonchè ricercare con la massima approssimazione il rendimento medio in *olio* che i prodotti delle diverse razze coltivate possono dare nell'oleificio razionale. Detti studi, per la scarsezza del materiale, per la mancanza del tempo e dei mezzi necessari ed infine per la non perfetta conservazione delle olive studiate, non è stato possibile eseguire per ora.

Ciò detto esponiamo nella tabella che segue la graduatoria delle forme colturali di olivo tripolitano in ordine alla maggiore evidenza ed importanza dei caratteri morfologici e chimici, da noi presi in considerazione.

Da quanto brevemente abbiamo esposto crediamo di poter dedurre quanto segue: —

1° La Tripolitania ha molteplici forme coltivate di olivo, che uno studio più dettagliato potrà ridurre ad un numero di razze forse più piccolo.

2° Alcune delle forme coltivate dimostrano di essere specialmente adatte a dare un prodotto ottimo per lo meno in quantità percentuale; dette forme debbono essere prese in seria considerazione dai coltivatori e dagli esperimentatori Italiani nella Colonia.

3° Tra le forme colturali esaminate specialmente quelle denominate: *Safràni*, *Mongàr agèl*, *Giabbùgi*, *Endùri*, *Rasli*, *Suabà arùss* si dimostrano particolarmente degne di essere in avvenire studiate ed estese nella grande coltura asciutta Tripolitana.

4° Sarà sommamente importante intraprendere uno studio dettagliato e continuato degli olivi tropolitani da parte delle Autorità Agronomiche della Colonia, potendo la coltura dell'olivo seriamente contribuire alla razionale e rapida messa in valore agraria della Tripolitania.

RISULTATI ANALITICI DELLE RICERCHE SU ALCUNI OLII DELLA TRIPOLITANIA.

Per il Dott. Alessandro Moreschini.

Avendo avuto occasione di esaminare in questo Laboratorio gli estratti eterei di 23 varietà di olive (polpe) provenienti dalla Msellata trovai un contenuto elevatissimo in sostanze non saponificabili: Da 1·57 ad 8·69 per cento, quindi sempre in dose molto maggiore della massima, che sulla fede del Dott. F. Czapek (confronta *Biochemie der Pflanzer*, pag. 713) sarebbe, per quanto si sappia, del 3 per cento. Credetti di poter spiegare il fatto con la presenza di sostanze coloranti (non sempre possibili a separarsi senza grandi perdite dall'esigua quantità di estratto che avea a mia disposizione), colla constatata presenza di gliceridi assai refrattari, e quindi facili a sfuggire, alla saponificazione (ciò che potrebbe interpetrarsi con la presenza di trioleina) e fors'anche con qualche alterazione dovuta alla lunga permanenza dei campioni nel liquido conservatore (alcool).

Avendo potuto più tardi disporre di altri campioni di olive più coltivate nel Garian e di olii provenienti da Zanzur e dalla Msellata, mi proposi di determinare: —

1° La quantità di sostanze non saponificabili sugli estratti eterei di olive conservate a secco.

2° La proporzione degli acidi grassi solidi e liquidi alla temperatura ordinaria (sapendosi già che molti olii Tunisini e Libici sono assai ricchi in acidi grassi solidi in confronto di olli Europei) allo scopo finale di vedere quale delle varietà di olive possedesse in minor grado il lamentato inconveniente e fosse quindi da preferirsi per le piantagioni avvenire.

3° La eventuale influenza del metodo di preparazione dell'olio (pressione o sbattimento nell'acqua; separazione delle pople dal nocciolo).

4° Verificare l'eventuale reazione d'Alphen e di Beaudoin (modificata da Villavecchia e Fabris) lamentato da

	Estratto Etereo delle varieta								Olii del Commercio			Olii preparati in Laboratorio dalla Varieta "Ghanimi"	
	Ghanìmi		Crusi		Gherràsi		Raciopiddu		"Dar-el-ma" Zanzur	"Masri" Msellata	Basilicata	Per pressione "Masri"	Per sbattimento nell'acqua "Dar-el-ma"
	Polpa	Nocciolo	Polpa	Nocciolo	Polpa	Nocciolo	Polpa	Nocciolo					
Liquidi (ac. oleico) ...	51·50	48·57	87·17	54·02	62·04	67·47	87·91	84·13	67·93	72·51	85·77	48·93	49·60
Punto di fusione: 62° C. (acido palmitico)	24·26	25·10	4·84	23·50	25·04	12·77	4·89	5·70	15·76	14·99	4·86	24·90	26·11
Punto di fusione: 69° C. acido stearico	17·84*	16·22*	1·11	11·61	2·00	9·99	1·13	2·77	6·89	3·93	1·99	15·06*	14·38*
Glicerina	2·86	7·06	3·97	8·36	8·81	6·62	3·47	4·39	7·87	6·62	6·30	9·66	8·93
Sostanze non saponificabili	3·54	3·05	2·91	2·45	2·11	3·15	2·60	3·01	1·55	1·95	1·09	1·45	0·98
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·co	100·co	100·00	100·00	100·00	100·00

* Il punto di fusione dell' acido non solubile nell' alcool saturo di acido stearico a 0° è a 71° C. ; non si tratterebbe quindi di acido stearico nur di un acido a maggior numero di atomi di carbonio o di una miscela di quello con questo.

R. Mareille (v. *Bull. de la Direction de l'Agriculture, du Commerce et de la Colonisation,* Anno 1909, No. 50, pag. 47-55) su alcuni olii Tunisini di recente preparazione.

Credetti opportuno prendere per confronto un olio ed un estratto etereo di olive (varietà Raciopiddu) provenienti dalla Basilicata, non avendo potuto per la stagione inoltrata procurarmi altre olive di altre regioni.

L'estrazione dei grassi con etere la saponificazione di questi, e degli olii preparati in laboratorio, o provenienti dal commercio, la separazione degli acidi grassi, i saggi di Alphen e di Villavecchia e Fabris furon condotti secondo i metodi adottati nel laboratorio delle R. Gabelle (vedi Villavecchia *Annali del laboratorio chimico centrale dell Gabelle,* vol. 5, parte I (1904). A meglio identificarli degli acidi grassi per tali metodi isolati venne volta per volta determinato il punto di fusione che, salvo il caso dell'oliva " Ghanìmi " di cui più avanti, corrisponde, salvo leggerissime differenze, nei limiti già dati da Heintz da una parte e da Hehner dall'altra, a quelli dell'acido palmitico e stearico, denominazioni che per ciò si crede di potere adottare pur non escludendo la possibilità della presenza di altri acidi secondari; la glicerina venne determinata per differenze ritenendo che nei grassi vegetali nonfossero contenute altre sostanze oltre a quelle determinate.

Da tutto quanto ho esposto e dall'esame della tabella qui sopra mi credo autorizzato a concludere: —

1° Tutti i campioni esaminati contengono quantità rilevanti di sostanze non saponificabili di natura indeterminata.

2° La quantità di glicerina essendo di molto inferiore a quella che corrisponderebbe agli acidi grassi, questi devono trovarsi per la massima parte allo stato libero.

3° La quantità di acidi grassi solidi è sempre molto elevata, specialmente nella varieta " Ghanìmi."

4° Benchè la ricchezza del contenuto in acidi solidi dei noccioli sia, nel caso delle varieti Crusi e Gherràsi, assai superiore a quello della relativa polpa, pure data la scarsa quantità del nocciolo in confronto alla polpa e lo scarso contenuto in olio (in media 13 per cento di estratto etereo) non si crede giustificata la pratica di separare la polpa dal nocciolo.

5° Ugualmente senza influenza è il metodo diverso di estrazione (sbattimento nell'acqua o pressione).

Lungi da ritenere decisivi i risultati di queste prime ricerche mi propongo di indagare sotto quali condizioni intrinseche od estrinseche di vegetazione possa variare la composizione degli olii.

THE FIXED OILS OF CEYLON.

By Alfred Lewis, F.L.S.

Late Conservator of Forests, Ceylon.

The natural oils of Ceylon may be classed under two heads—Fixed and Essential—both of which are obtained from trees and plants common to, or introduced into, the Island. So far, no mineral oils have been obtained.

Of the vegetable oils we have two classes, viz. (*a*) those used by the rural inhabitants for domestic purposes confined to home use, either medicinal or otherwise, and (*b*) those entering into commercial use or trade. Of the former, with a few exceptions, the quantity is generally restricted to the specific wants that call them into use, so that while the source of supply is not specially limited, the demand is. It may therefore be desirable to refer to this section as oils of minor importance, leaving all the others under the head of commercial fixed oils.

Section I.—*Fixed Oils of Minor Importance.*

(1) *Trichadenia zeylanica*, Thw. (1855) ("Tolol," or "Thitta-etta," Sing.). The oil from this rather scarce wet-zone tree, is obtained by first bruising the seeds by pounding them, and then compressing the meal so obtained in a rough lever-press, acting on the envelope containing the crushed seeds. A small quantity of thick oil is thus obtained and used for skin diseases. It is supposed to be efficacious in forms of ecthyma.

(2) *Hydnocarpus venenata*, Gaertn. (1788) ("Makulu," Sing.).—An oil is obtained from the seed of this plant that is alleged by the natives to be of use in leprosy. Little is known of the method of obtaining the oil, but it is believed to be by first crushing the seeds and then boiling, the oil being skimmed off after.

The "Makulu" tree is fairly abundant in Ceylon as a riverside tree, and is found from sea-level to about 2,000 ft. altitude. The fruits are narcotic and are used as a fish poison. It is alleged, and with good grounds for belief, that during the season when this plant is in ripe fruit, it is unsafe to eat fish or crayfish caught in the streams where the "Makulu" trees are very abundant, as the flesh of these animals becomes poisoned while they have been feeding on the decomposed seeds.

This plant, like the last-mentioned species, belongs to the Bixaceæ.

(3) *Garcinia echinocarpa*, Thw. (1854) ("Madol," Sing.).—One of the Guttiferæ, a widely distributed endemic tree, found chiefly in the wet parts of the island up to high altitudes. In many parts of the country it is particularly plentiful, as is indicated by the place-name, *Madolkelle* (*i.e.*, the forest of "Madol"). The oil obtained from the seed was at one time commonly used as an illuminant by the poorest classes, but it has been almost entirely superseded by kerosene. The oil was extracted by first pounding the kernels, and then exposing the pounded mass, spread thinly over a mat, to the sun, till the required degree of rancidity was obtained, and finally compressing the material in a wedge or lever-press. The crude oil so obtained is thick and of a dark brown colour. It burns moderately well.

(4) *Calophyllum Inophyllum*, Linn. (1753) ("Tel-domba," Sing., "Punnai," Tamil).—Known to early writers as the "Punnai-nut," in which at one time there was some considerable trade. The seeds possess a high percentage of oil, which is obtained by crushing and pressure. This oil is known in Europe as Domba-oil, and is valued as an external application in rheumatism and in itch. The oil is thick and dense, and when fresh is yellowish in colour and fragrant.

This species is also one of the Guttiferæ. It is chiefly confined to the low-country, and is found both in the wet and dry zones. It is frequently found in comparative abundance on the sea-coast, but it is not a forest tree.

The export of "Punnai" nuts from Ceylon at one time showed a value, according to the Customs figures, of Rs. 12,300, but the trade in this commodity is now very restricted.

(5) *Calophyllum tomentosum*, Wight (1843) (" Kina ").—The oil obtained from the seed of this species by expression is dense, sticky, and fragrant. It is highly valued by natives for scabies, but its use is purely local.

The " Kina " tree is moderately abundant throughout the western forests of the island above 2,000 ft. altitude, but becomes rare at 4,000 ft. It affords an excellent timber for house-building purposes.

(6) *Mesua ferrea*, Linn. (1753) (" Na," Sing.; " Iron-wood ").—This guttiferous tree affords one of our most valuable building woods, the timber being both hard and very durable. The " Iron-wood " tree is found widely distributed throughout the island, and occurs both as a purely forest tree and as an introduction in those localities where from its great beauty and fragrant flowers it has special use as a " Sacred tree." In this way the " Iron-wood " tree has been introduced into many parts of the dry zone, though its natural localities are in the wet forests. It is common in India, Burma, and in the Andamans. In Ceylon it is found at 200 ft. to 4,000 ft. altitude in the western side of the island.

The fixed oil is obtained from the seeds by bruising and expressing. It is valued in native medicine for external application in cutaneous diseases, and is also used as an embrocation in rheumatic complaints.

(7) *Azadirachta indica*, A. Juss. (1830) (" Margosa " tree, or " Nim "; " Kohomba," Sing.; " Vempu," or " Veppanai," Tamil).—This handsome tree, belonging to the Meliaceæ, is chiefly confined to the dry country. It is abundant near the coast, especially in districts where the Tamil population preponderates, and who probably introduced it. The seed yields a most cherished oil, obtained by crushing and expressing.

The oil is in high favour, owing to its antiseptic properties, hence its use in dressing all manner of foul ulcers in animals as well as human beings. It is used alone, or in conjunction with other oils, in eczema, scrofula, and other skin diseases, and its application in a crude form to the body is alleged to be stimulating. The Tamils also eat the oil mixed with boiled rice as a remedy for intestinal worms. Applied to the hair, Margosa oil is used for the destruction of lice, and it is applied as a dressing in sores on cattle to prevent flies from affecting the wound or ulcer. To the European, however, the odour of Margosa oil is intolerable, as its smell is like rotten garlic.

It is believed that this tree, planted near villages, acts as a prophylactic against malaria. It is nowhere found as a forest tree in Ceylon, but its occurrence in abandoned villages has sometimes led to the erroneous idea that it is a wild species here.

(8) *Kokoona zeylanica*, Thw. (1853) ("Kokun," Sing.).—One of the Celastraceæ, and chiefly confined to the wet forests, and occasionally found in some abundance.

In the large Gillimale village, through which the Pilgrims' path from Ratnapura to Adam's Peak passes, a small local trade is carried on during the pilgrim season in the oil obtained from the seed of this plant.

The oil is a thick, dark, tar-like liquid, obtained by expression from the pounded seeds, and is used entirely for removing or keeping off leeches from the feet and legs of the pilgrims. By smearing the oil over the feet, the leeches are destroyed, the effect being to cause the animal to fall off and die, much in the same manner as follows from the application of strong tobacco juice. The oil is sold for as much as Rs. 8 per pint, and is locally known as "Pottu-eta-tel." It is said to be highly poisonous and intensely bitter, but its use appears to be very little known outside the village named, where the writer first found it in use in 1890.

(9) *Bassia longifolia*, Linn. (1771) ("Mi," Sing.; "Illupai," Tamil).—A very magnificent deciduous tree, generally found in the low-country, where it has been introduced and to a great extent become naturalized. It is, however, rarely found above 2,000 ft. altitude, except under very favourable conditions.

This sapotaceous tree affords abundant crops of seed, which are pounded, and the fixed oil is obtained by expression; various methods are in use for that purpose, such as lever-presses, wedge-presses, and rope compression.

The oil is used as an illuminant, and at one time was in considerable demand for this purpose, till the more useful and cheaper kerosene displaced it. It is, however, still valued as a specific for skin diseases, and is applied in swellings as an embrocation. The oil-cake is exported from Jaffna, and appears under the title of "Arrapo."

(10) *Aleurites triloba*, Forst. (1771) ("Tel-kekuna," Sing.; "Candle-nut"; "Otaheite walnut").—One of the Euphorbiaceæ and introduced into Ceylon probably from the South Pacific or Moluccas where it is natural. In Ceylon it is cultivated, and becomes a large handsome tree, found in some abundance in the Central Province and again in the Sabaragamuwa Province up to about 3,000 ft. altitude.

Its value in Ceylon as an oil-producing plant has not received much attention, notwithstanding the high oil content of the seeds, probably owing to the exceedingly hard shell enclosing the kernel, for the rapid and cheap treatment of which no machine has, so far, been introduced.

The fact that about 10,000 gallons of oil are annually produced in the Sandwich Islands should warrant its better attention in Ceylon, where, however, so little value is attached to it that the "Kekuna" trees are frequently felled and the timber used for making very inferior packing-cases. In parts of the country, however, where the seeds can be obtained in considerable quantity, the oil is used as an illuminant. It burns with a bright clear light, and is free from smell.

(11) *Croton Tiglium*, Linn. ("Jaya-pala," Sing.; "Croton").—An introduced plant, probably brought to Ceylon previous to the occupation of the country by the Dutch, but at no time has it attracted much native attention, probably owing to its poisonous nature. After the disaster which overtook the coffee enterprise, a little attention was paid by Europeans to this product, resulting in the export in 1893 reaching as much as 262 cwts., valued at about Rs. 11 per cwt. The demand, however, at no time justified any serious attention being devoted to Croton as a commercial enterprise.

In native medicine the oil is valued, not only as a drastic purgative, but, in association with coconut and other oils, as a liniment. The fumes from roasting Croton seeds, inhaled through the nose, are alleged to relieve asthma. In Indian native medicine Croton enters frequently, in connection with other oils, juices, or pulps.

The local methods of preparation of the oil vary generally with the specific purpose to which it has to be applied; thus, in some cases, it is obtained by expression, and in others, by boiling with milk.

(12) *Ricinus communis*, Linn. ("Endaru," Sing.; the castor oil of medicine).—The date of the introduction of this well-known plant into Ceylon is uncertain, but probably it was first brought from India. It is found over nearly the whole island, both in wet and dry districts alike, but except as "escapes" it is nowhere actually wild. The oil is obtained both by expression and by boiling, and is in very large demand for medicinal purposes, and as a machine oil or lubricant. Among the Tamils, who call the oil "Velakennai," it is particularly popular, especially for local application, it being no uncommon sight to find a Tamil woman smearing the body of her infant with it till the child looks as if it was bathed in this uninviting substance. Apart from its known value as a purgative, other parts of the plant are reputed to be important in native medicine, a decoction of the root being used, for example, in pleurodynia. The leaves are esteemed as of value for affections of the eye.

The meal, or "poonac," as it is called, which is left after the oil has been expressed from the seeds, constitutes a most valuable manure, very large quantities being imported into the island from India and elsewhere for this purpose.

The cultivation of the castor oil plant in areas not adapted to permanent cultures is worthy of serious attention, both in view of the demand for the product and the ease with which it can be raised.

Section 2.—Fixed Oils of Major Importance.

(1) *Cocos nucifera*, Linn. (1753) ("Pol," Sing.; "Tennai," Tamil; the coconut of the European).—The introduction of the coconut into Ceylon is a matter of much

academic interest, but it is inappropriate here to deal with this particular question. It is, however, significant that the historical work—the Mahawanso—does not refer to it before the reign of Parakarama the First, that is, about 1153 A.D., nor does it speak of the coconut as an article of food.

Since its introduction, however, it has been systematically cultivated throughout the greater part of the island, except where arid conditions on the one hand, or altitude on the other, precluded its successful rearing. The trade in coconut oil and copra alone has for the last fifty years formed a prominent item in the commerce of this island, and in recent years has attracted much capital from outside the colony. It is noteworthy of remark, that writing in 1817, Dr. Davy refers to an extensive plantation of coconut trees situated about 1½ miles from Ruwanwella, as being the property of Government.

In 1839 the value of the coconut oil exported amounted to £26,597, increasing in 1859 to £118,864. In 1841, systematic coconut cultivation by Europeans, on an extensive scale, was first commenced. In 1861, in the Northern Province, thirty estates were in European hands, while twenty were owned in the Eastern, and some thirteen in the Western Province. From that time the development of the enterprise grew steadily and became more and more in the hands of the natives. Our exports now extend practically to all the chief markets of the world. The exports of copra and coconut oil from Ceylon in the years 1840 to 1910 are shown in the tables on pages 338 and 339:—

The old methods of oil extraction, with the aid of the cattle mill or "Chekku," are still followed in many parts of the country, but modern machinery has largely replaced these romantic methods of two centuries ago. The sound of the creaking mill is still heard in the wilder parts of Ceylon, where modern ways and means have not entered and destroyed the rustic simplicity of the people or their quaint tools of trade.

Ceylon coconut oil has always stood high in the estimation of merchants, owing to its purity and clearness, and it is probably due to this factor that it has

EXPORTS OF COPRA AND COCONUT OIL FROM CEYLON, 1840 TO 1888.[1]

Year	Copra		Coconut Oil	
	Quantity	Value	Quantity	Value
	Cwts.	£	Gallons	£
1840	6,605	2,507	475,742	32,481
1840-1	3,639	1,458	321,965	24,061
1841-2	8,419	3,020	475,967	34,242
1843 } 1844 }	no records available			
1845	10,562	3,175	282,186	15,944
1846	13,829	5,506	123,980	7,938
1847	14,811	6,503	197,849	18,541
1848	33,535	12,638	311,526 and 8 pkgs.	24,838
1849	29,360	7,819	513,278	34,831
1850	11,305	4,165	407,959	35,035
1851	27,026	9,678	443,698 and 22 jars	31,444
1852	39,173	13,325	749,028 and 4 pkgs.	58,045
1853	37,577	16,183	1,033,973	95,990
1854	52,841	30,200	1,059,272	121,297
1855	27,296	16,586	908,742	108,913
1856	29,910	16,446	1,046,326 and 1 case	101,590
1857	19,554	11,627	1,679,258	212,184
			Cwts.	
1858	32,609	19,565	62,450	77,716
1859	10,081	6,049	95,515	118,864
1860	13,766	8,260	124,480	154,909
1861	27,279	16,368	83,605	104,043
1862	19,595	11,757	114,873	142,953
1863	33,723	20,234	150,967	187,853
1864	29,326	17,795	180,755	224,947
1865	11,998	7,199	94,563	120,678
1866	55,569	33,032	83,800	104,400
1867	23,302	13,981	108,119	134,548
1868	5,338	3,203	114,416	142,385
1869	17,648	10,589	103,826	129,206
1870	40,638	31,678	135,658	170,211
1871	50,573	44,625	207,136	257,519
		Rs.		Rs.
1872	41,751	277,389	278,216	3,306,891
1873	34,461	190,868	113,871	1,418,183
1874	29,362	188,417	145,078 and 21 pkgs.	1,806,629
1875	8,021	50,264	123,854 and 9 pkgs.	1,541,722
1876	28,115	174,196	212,971 and 32 pkgs.	2,653,162
1877	19,593	158,637	132,740	1,651,880
1878	45,705	398,592	175,423	2,183,052
1879	64,862	529,651	218,389	2,717,739
1880	92,761	912,489	352,479	4,386,414
1881	54,139	365,474	201,566	2,508,378
1882	95,837	716,834	210,954	2,625,207
1883	171,049	1,496,239	348,381	4,335,420
1884	202,203	1,644,332	383,955	4,778,115
1885	161,710	1,277,003	265,183	3,300,065
1886	156,519	1,377,401	277,311	3,450,985
1887	136,346	1,070,561	323,445	4,025,098
1888	147,355	1,254,904	364,116	4,531,222

[1] Figures not available separately for Colombo and Galle for these years.

Exports of Copra and Coconut Oil from Ceylon, 1889 to 1910.

Year	Copra				Coconut Oil			
	Colombo		Galle		Colombo		Galle	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	Cwts.	Rs.	Cwts.	Rs.	Cwts.	Rs.	Cwts.	Rs.
1889	54,110	423,196	851	6,219	334,947	4,168,261	44,987	559,841
1890	150,238	1,443,297	5,956	37,520	323,400	4,024,527	45,324	564,034
1891	64,738	889,586	4,169	31,798	378,639	4,711,954	48,030	597,711
1892	168,694	1,622,215	379	2,870	497,311	6,188,662	67,239	836,750
1893	77,077	1,157,745	484	5,280	341,857	5,317,775	46,048	716,297
1894	45,338	575,371	103	1,350	422,739	6,575,932	25,834	401,861
1895	31,672	370.586	44	985	364,823	5,675,030	54,167	842,597
1896	50.257	496,618	—	—	335,843	5,524,000	54,970	555,295
1897	115,257	1,125,984	209	2,260	451,702	5,903.745	36,640	478,884
1898	512,036	4,984,171	26	130	415,314	5,428,157	52,012	679,790
1899	315,734	3,164,221	53	530	382,796	5,389,763	47,731	672,052
1900	397,904	3,891,134	1,902	16,980	400,215	5,703,062	68,059	969,840
1901	451,634	4,489,178	191	1,335	421,589	6,758,056	52,599	843,177
1902	377,173	4,094,747	62	310	499,487	9,065,694	51,904	942,057
1903	731,059	7,523,267	270	2,160	622,098	9,972,231	65,525	1,050,365
1904	722,834	7,971,993	—	—	445,781	8,024,058	65,177	1,173,186
1905	389,023	4,881,476	1,564	15,093	523,163	8,742,053	64,258	1,073,751
1906	444,981	5,623,017	1,037	10,583	487.595	8,635,308	51,407	910,417
1907	381,568	5,290,836	760	6,767	423,021	10,457,079	55,552	1,373,245
1908	746,966	8,329,269	1,353	21,808	566,857	10,543,540	77,457	1,440,700
1909	783,100	9,991,803	697	8,625	518,217	11,354,134	81,578	1,787,374
1910	746,856	12,498,680	11,855	199,045	539,586	15,086,824	80,094	2,239,428

always been in steady demand, and, unlike other Ceylon-grown products, has been free from violent and sudden fluctuations in price, to the danger of trade.

(2) *Sesamum indicum*, Linn. (1753) ("Tala," or "Tel-tala," Sing.; "Ella," Tamil).—This plant is one of the Pedaliaceæ, and affords the "gingelly oil" of commerce. Two varieties exist in Ceylon, one with pale pinkish-purple flowers, and the other white. It is practically a weed, and is often found growing wild in waste ground, but it probably was at once time introduced into the country.

It is planted as a "Chena" crop in the dry districts, but authorities vary greatly as to the yield per acre. In parts of the Southern Province it produces very large crops, but that notwithstanding, its systematic cultivation is not followed. In the North-Central Province it is more regularly cultivated than in the South, and forms an important element in the trade of the poorer classes, the price obtained for the oil being about Rs. 3 per gallon. Three varieties of the seed are found, known as black, white and red. Of these, black is the most common, and produces the best quality of oil. The oil is of medicinal value, in addition to its use as an illuminant, being used in native medicine as a demulcent and laxative. A poultice made from the seed is frequently a favourite for sores. The meal is in large demand for manurial purposes, and is largely imported for that purpose into the island.

The local trade in gingelly seed is considerable, and large quantities are exported to India and elsewhere, where its value as a commercial commodity is appreciated much in the same way as rape seed in Europe and for like uses.

Wood Oils.

A passing reference to wood oils may not be out of place, though practically one kind alone is worthy of note. This is a thick, turgid, sub-resinous fluid, obtained from a gigantic Dipterocarp, known as "Dorana" (*Dipterocarpus glandulosus*, Thw.).

The oil is obtained by first excavating a deep notch in the stem of the tree and lighting, within the cavity so formed, a small fire from broken coconut shells or wood chips. The heat from the flame draws the wood oil down, which trickles into the back or apex of the cavity cut into the wood, from which it is removed later. This crude process of extraction is both wasteful and destructive to the tree, and many splendid "Dorana" trees are completely destroyed thereby. This is the more deplorable as the tree is by no means abundantly distributed in our forests, and where it occurs it is usually confined to restricted gregarious clumps or clusters of no great extent.

"Dorana" oil is one of the ingredients used in the preparation of pigments for Kandyan paintings. It is generally used mixed with the resin of the "Hal" tree (*Vateria indica*, Linn.), the combination making an excellent varnish.

The oil is also employed in a native method of catching the rice-bug (*Leptocorisa varicornis*), which is often very plentiful and exceedingly disastrous to the rice crop. In this process, known in Singhalese as "Bokkugewima," the wood oil is added to the latex of a species of *Willughbeia*, or a *Palaquium*, and mixed into a viscous mass. This fluid is then placed in a shallow scoop, or boat-shaped vessel, made from closely plaited bamboo, that is sufficiently porous to allow the mixture to ooze through slowly so as to cover the lower sides of the apparatus with a thick, gummy slime. The scoop is attached to a light frame that in turn is attached to a long slender pole by means of which the scoop is swept over the rice fields, just at the time the young ears of rice are beginning to ripen, the rice-bugs being caught on the sticky slime. In parts of the Ratnapura District of the Sabaragamuwa Province this form of "bug-liming" is much in vogue, but where the fields are very large there are obvious practical objections to its general application.

"Dorana" oil is believed to be of value as a remedy for rheumatic affections.

Another wood oil obtained from an allied tree (*Dipterocarpus zeylanicus*, Thw.) is used for caulking cracks in boats or canoes. It is more resinous than the last, and when dry forms a thick, water-tight paste. This wood oil, known as "Hora-itti," is obtained either by cutting the tree down and allowing the oil to flow naturally, or by cutting deep notches into the stem of the tree, into which the liquid exudes without heating. Mixed with beeswax, the wood oil of *D. zeylanicus* affords a rough varnish, but this is not much used. Its medicinal value does not appear to be high.

SUR LA COMPOSITION DE DIVERSES GRAINES OLEAGINEUSES DE L'AFRIQUE FRANÇAISE.

Par M. Alexandre Hébert.

Nous avons eu occasion, dans ces derniers temps, d'étudier diverses graines oléagineuses provenant des possessions africaines françaises, et qui n'avaient pas encore été examinées au point de vue chimique. De ces graines, les unes sont originaires de l'Afrique occidentale: Soudan et Gabon; les autres proviennent de Madagascar. Nous donnons ci-après l'étude particulière de chacune d'elles.

Fruits de *Sorindeia oleosa*.

1° La matière première de cette étude consistait en fruits séchés au soleil de *Sorindeia oleosa*. A. Chev., qui nous avaient été adressés par M. Auguste Chevalier et qui provenaient d'un arbre commun au Soudan. Ce sont des fruits à noyau entouré de pulpe et de la grosseur d'une cerise; ils ont deux usages et ont été examiné à deux points de vue:—

(1) La pulpe ou péricarpe du fruit est très sucrée; dans le pays d'origine, on fait fermenter ces fruits pour en obtenir une boisson analogue au cidre; (2) l'amande de la graine proprement dite, qui forme le noyau du fruit, est très oléagineuse; on en extrait de l'huile et on en prépare du savon.

Il convenait donc de vérifier, d'une part, la nature et la proportion du sucre existant dans la pulpe du fruit; d'autre part, la quantité et les propriétés de la matière grasse contenue dans les amandes.

2° Pour effectuer l'étude chimique de ces fruits aux points de vue qui nous intéressaient, nous avons commencé par séparer les pulpes et les noyaux. A cet effet, 500 grammes de ces fruits séchés ont été mis en contact avec une quantité d'eau froide suffisante pour les recouvrir; après 24 heures de séjour, ils s'étaient gonflés et étaient d'une consistance telle qu'ils pouvaient être malaxés dans l'eau sans risquer d'écraser les noyaux. Ceux-ci, séparés ainsi des pulpes, ont été desséchés à l'air et mis de côté pour un examen ultérieur. On les a trouvés en proportion de 40 pour 100 des fruits, accusant ainsi 60 pour 100 de pulpes.

Les pulpes gonflées ont été épuisées à trois reprises par l'eau froide pour dissoudre toutes les matières solubles et notamment les sucres qui s'y trouvaient. Finalement le résidu a été pressé et le liquide provenant de ce pressurage a été joint aux liqueurs d'épuisement. Celles-ci ont été déféquées par le sous-acétate de plomb et le liquide filtré a été débarrassé de l'excès de plomb par l'hydrogène sulfuré. La solution incolore ainsi obtenue a été concentrée dans le vide au bain-marie à très basse température jusqu'à consistance sirupeuse, puis abandonnée à elle-même. Elle a refusé de cristalliser, malgré tous les subterfuges habituels employés dans ce but: concentrations diverses, reprises par l'alcool traitement au noir animal, etc. Le sirop réduisait énergiquement la liqueur de Fehling, donnait avec l'acétate de phényl-hydrazine une osazone cristallisée en aiguilles groupées en forme d'éventail, fusibles à 200° et correspondant aux propriétés de la phényl-glucosazone, déviait enfin à gauche le plan de polarisation de la lumière, mais cette déviation correspondait à une quantité de sucre réducteur bien plus faible que celle indiquée par le titrage à la liqueur de Fehling. Somme toute, ces caractères répondaient au sucre interverti.

D'autre part, on a trouvé dans une quantité donnée des fruits secs, épuisés par l'eau froide comme nous l'avons indiqué, et par titrage à la liqueur de Fehling, une proportion de 22 pour 100 de sucres réducteurs et une quantité nulle de sucres non réducteurs. Si nous admettons dans ces fruits, à l'état frais, une teneur en eau égale à 90 ou 95 pour 100, teneur qu'on retrouve généralement dans les fruits de ce genre, la proportion de sucres réducteurs correspondrait à 1:10 ou 2:20 pour 100 des mêmes fruits à l'état frais.

Il résulterait de ces expériences que les matières sucrées des fruits de *Sorindeia oleosa*, A. Chev., seraient constituées par du sucre interverti, mélange de glucose et de lévulose, ce qui justifierait leur emploi indigène pour la préparation d'une boisson plus ou moins alcoolique, et du genre du cidre, mais qui, en tous cas, ne peut certainement être que très peu riche en alcool.

3° Les noyaux, obtenus comme nous l'avons dit, et qui constituaient 40 pour 100 des fruits secs, renferment 24 pour 100 de ces mêmes fruits secs en amandes. Celles-ci, après broyage et extraction à la benzine, lui abandonnent une matière grasse dont la proportion atteint 25 pour 100 des fruits secs.

La matière grasse obtenue est solide à la température ordinaire, de couleur brunâtre et présente les constantes suivantes : —

Densité à 17°	0·889
Point de fusion	16-17°
Point de congélation	12-13°
Indice d'acidité	4·90
,, de saponification...	185·00
,, de Reichert	7·92
,, d'Hehner	91·75
,, d'iode	132·00

La graisse de *Sorindeia oleosa,* A. Chev., saponifiée par la soude alcoolique et acidifiée, fournit 92 pour 100 environ d'acides gras, jaunâtres, solides à la température ordinaire, fusibles à 39°-40°. La séparation des acides gras saturés et incomplets effectuée par l'épuisement à l'éther des sels de plomb, a donné 24 pour 100 d'acides incomplets, liquides, de couleur jaune brunâtre, et 76 pour 100 d'acides saturés, solides, colorés en jaune brun, fondant à 44°-45°. Ce point de fusion assez bas indique l'existence, dans la graisse étudiée, d'acides gras relativement inférieurs. L'usage de la graisse de *Sorindeia oleosa,* A. Chev., pour la préparation du savon se comprend ainsi parfaitement, cette substance grasse d'une part ne paraissant pas comestible, et d'autre part donnant des acides gras à point de fusion trop bas pour servir à la fabrication de bougies ou même de chandelles.

GRAINES DE *Chrysophyllum congoense.*[1]

1° Ces graines constituent les fruits d'une sapotacée provenant d'un très grand arbre qui croît dans la forêt

[1] Par MM. Alexandre Hébert et Auguste Moog.

vierge du Gabon et qui ressemblent absolument aux graines du *Gambeya congoensis*, Pierre (ined. in Herb. Mus. Paris).[2]

Ces graines ont été recueillies au Gabon, à Agonenzorck, sur le Komo, dans la forêt vierge; elles ont été séchées à l'air avant leur expédition. A cet état, tel qu'elles nous ont été remises, elles pesaient individuellement 4 gr. 75 en moyenne; après décorticage, les amandes formaient 175 pour 1,000 de leur poids, l'enveloppe ligneuse formant le complément, soit 825 pour 1,000. La matière grasse a été obtenue en épuisant les graines moulues à la benzine qui, après évaporation, a fourni 14 pour 100 des amandes (soit 2·4 pour 100 des fruits complets) d'une huile semi-solide à la température ordinaire, assez fortement colorée en rouge-brun acajou et qui présentait les constantes suivantes:—

Densité à 15°	0·870
Point de fusion complète	31°
Indice d'acidité	68·5
,, de saponification	175·7
,, de Reichert	1·76
,, d'Hehner	95
,, d'Iode	49·9
Point de fusion des acides gras	40°

On remarquera que l'indice d'acidité de cette huile est extrêmement élevé; diverses vérifications nous ont conduits au même chiffre. Il semblerait donc au premier abord que la graine en question renferme une lipase, capable de saponifier la matière grasse et de la dédoubler en glycerine et acides gras; c'est là un point que nous étudions plus loin.

La matière grasse, après saponification par la soude alcoolique et mise en liberté par l'acide sulfurique des acides gras du savon formé, en a donné un rendement approximatif de 95 pour 100. Ces acides gras totaux ont été séparés en acides saturés solides et en acides non saturés liquides de la façon suivante: Ils ont été transformés en sels d'ammonium par solution dans

[2] Ces graines seront étudiées botaniquement dans le fascicule des *Végétaux utiles de l'Afrique tropicale française*, consacré au Gabon et qui paraîtra prochainement chez Challamel, éditeur, Paris.

l'ammoniaque étendue, puis en sels de plomb par addition d'acétate de plomb. Ces sels plombiques ont été filtrés, séchés dans le vide et épuisés par l'éther dissolvant seulement les sels des acides gras non saturés. Des deux parties ainsi séparées, on a régénéré les acides gras par traitement à l'acide chlorhydrique étendu; ces acides gras ont été recueillis, séchés et pesés. On a trouvé poids égal des deux sortes d'acides: saturés solides et non saturés liquides.

Les acides non saturés liquides étaient jaunes; traités par le nitrate acide de mercure, ils ont pu être transformés en acide élaïdique, cristallisé, fusible à 42°; ce qui correspond aux caractères de l'acide oléique.

Les acides saturés solides ont été transformés en sels d'ammonium par dissolution dans l'ammoniaque étendue et sur cette solution on a effectué trois précipitations fractionnées à l'état de sels de magnésium, par additions successives d'acétate de magnésium. Les précipités partiels, obtenus, traités par l'acide chlorhydrique étendu, ont régénéré trois fractions d'acides gras qui fondaient aux températures suivantes:—

1e fraction	49°
2e ,, ...	40°
3e ,, ...	40°

Ces trois fractions ont été transformés en sels d'ammonium, puis en sels de baryum par addition de chlorure de baryum, et ces sels barytiques ont été filtrés et séchés à froid dans le vide sec; on y a dosé le baryum par calcination d'un poids connu de ces sels, qui laissait comme résidu du carbonate de baryum, d'où l'on déduisait la proportion de baryum. On a trouvé:—

1e fraction	22·70 pour cent de baryum
2e ,, ...	25·48
3e ,, ...	25·53

Si l'on calcule le baryum correspondant aux sels de baryum des acides gras se rapprochant le plus de ces teneurs, on trouve, en baryum pour cent:—

Pour $(C_{16}H_{31}O_2)_2Ba$ (acide palmitique)	21·2
,, $(C_{14}H_{27}O_2)_2Ba$ (acide myristique)	23·3
,, $(C_{12}H_{23}O_2)_2Ba$ (acide laurique)	25·7

D'après ces chiffres, la première fraction se montrerait intermédiaire entre l'acide palmitique, fondant à 62°, et l'acide myristique fondant à 53·8°; mais son point de fusion, 49°, le rapprocherait davantage de ce dernier; les 2e et 3e fractions, qui fondent à la même température et dont les sels barytiques présentent la même teneur en baryum, paraissent identiques et se rapprocheraient de l'acide laurique, fondant à 43·6°. La matière grasse des graines du *Chrysophyllum congoense* doit donc être formé par des glycerides de l'acide oléique, d'une part, et des acides laurique, myristique et peut-être palmitique, d'autre part.

2° Quant au tourteau qui reste comme résidu, après l'épuisement des graines moulues par la benzine, il se présente sous la forme habituelle de ces produits; il possède un goût un peu amer. Etant donné qu'il provient d'une graine de sapotacée, nous y avons recherché la présence de saponine. Pour cela, une certaine quantité de ce tourteau séché a été épuisée par l'alcool bouillant qui a laissé déposer une poudre jaunâtre qu'on a recueillie et qui a été purifiée par redissolutions successives dans l'alcool bouillant et reprécipitations par refroidissement. On a obtenu ainsi, par dessiccation finale à froid dans le vide, une poudre blanche, douée de propriétés stimulatoires, dont les solutions aqueuses moussent abondamment, ne réduisent pas directement la liqueur de Fehling, mais la réduisent au contraire après interversion par ébullition avec les acides dilués. Ces propriétés répondaient à celles de la saponine, dont on peut évaluer la proportion à 0·5 pour 1,000 parties du tourteau.

On a recherché également dans le tourteau la présence d'alcaloïdes pour être fixé de suite, sur la possibilité de le faire entrer dans l'alimentation du bétail. A cet effet, on a fait digérér 500 gr. de tourteau séché avec de l'eau aiguisée de 5 pour cent d'acide sulfurique; après filtration et essorage du tourteau, le liquide acide a été alcalinisé par la soude et épuisé à l'éther, devant dissoudre dans ces conditions les matières alcaloïdiques mises en liberté. L'extrait éthéré était peu soluble dans l'eau, soluble dans les solvants organiques, présentait une réaction alcaline, était soluble dans les acides étendus, et ses solutions aqueuses précipitaient par les réactifs généraux des alcaloïdes: Bouchardat, Tauret, acide picrique, ferrocyanure de potassium acétique, chlorure mercurique. Bien qu'on n'ait pas eu assez de matière pour chercher à déterminer la nature de l'acaloïde existant dans le tourteau, il semble qu'on puisse en estimer la quantité à 0·1 pour 1,000 environ, et qu'il conviendrait d'éloigner ce tourteau de l'alimentation des animaux.

En dehors de ces substances, l'analyse a indiqué pour ce tourteau la composition immédiate suivante:—

Matières minérales	2·90
Matières azotées	12·25
Sucres réducteurs	13·33
Sucres non réducteurs	6·67
Acides végétaux, gommes, tannins, etc.	8·45
Cellulose	13·00
Gommes hydrolysables, xylane	32·00
Amidon	Néant
Vasculose	11·40
Total	100·00

Ce tourteau pourrait donc servir d'engrais malgré sa teneur moyenne en substances azotées et sa faible proportion de matières minérales.

D'ailleurs, les graines de *Chrysophyllum congoense* ne paraissent pas devoir être recommandés pour l'extraction de leur matière grasse, à cause du faible rendement et de la concurrence avantageuse que leur font d'autres graines exotiques.

3° Nous avons fait remarquer plus haut que l'indice d'acidité de l'huile de *Chrysophyllum congoense* était extrêmement élevé et pourrait peut-être faire prévoir dans cette graine l'existence d'une lipase saponifiante, susceptible de dédoubler la graisse en glycérine et acides gras, en augmentant ainsi son acidité.

Pour vérifier ce point, nous avons employé le mode d'opération recommandé par Nicloux[3] et nous avons agi simultanément sur les graines ci-dessus, en même temps que sur des graines de ricin pour avoir un point de comparaison au sujet de l'existence d'une lipase.

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[3] "Contribution à l'Etude de la saponification des corps gras." Hermann, éditeur, Paris, 1906.

Les essais étaient effectués en mettant dans un verre de montre 0·5 gr. d'amandes à expérimenter, broyées au mortier aussi finement que possible, 0·9 gr. d'huile de coton et 0·4 c.c. d'acide acétique décinormal. On obtenait et on maintenait l'émulsion du mélange par son agitation fréquente avec une petite baguette be verre, agitation identique, de même durée et aux mêmes intervalles de temps pour les divers essais et les différents échantillons. Après les laps de temps que nous nous étions fixés suivant les expériences, on faisait tomber le contenu du verre de montre dans un verre à expériences avec de l'alcool étheré, contenant volumes égaux d'alcool et d'éther; on ajoutait à ce liquide quelques gouttes de phénol-phtaléine et on titrait l'acidité du mélange avec une solution de soude au cinquième normale et non carbonatée (préparée avec du sodium). Le tableau suivant indique les résultats obtenus:—

	Chrysophyllum congoense	Ricinus communis major
	c.c.	c.c.
Acidité initiale	0·5 NaOH N/5	0·8 NaOH N/5
,, après 15 minutes...	0·6	3·0
,, ,, 30 ,, ...	0·5	4·9
,, ,, 1 heure ...	0·6	8·0

Le mode opératoire employé était correct, puisque la graine de ricin manifeste son pouvoir saponifiant habituel; mais on voit que l'acidité du mélange n'a pas varié sensiblement par addition des graines broyées du *Chrysophyllum congoense.* On ne peut donc caractériser ainsi l'existence de lipase dans ces graines, ou tout au moins de lipase analogue à celle du ricin.

Graines de deux Espèces de *Symphonia.*

1° Sur le versant oriental de Madagascar, les indigènes utilisent, pour l'extraction de l'huile, les graines de divers arbres, notamment de plusieurs espèces de *Symphonia,* plantes de la famille des Clusiacées. Parmi celles-ci, dans la forêt d'Analamazaotra, il en est une que les habitants de la région appellent *Kizalahy* et que MM. Jumelle et Perrier de la Bathie, qui l'ont étudiée botaniquement, ont dénominée *Symphonia lævis.* Elle est constituée par un arbre de 10 à 15 mètres de haut, exsudant une résine jaune d'or brunissant à l'air, possédant des feuilles persistantes, à fleurs rouges, à fruits de surface lisse affectant la forme de petites poires renversées de 6 cent. de hauteur sur 6 de largeur maxima, renfermant de 4 à 6 graines polyédriques.

Une autre espèce, dénommée *Kizavavy* dans le pays, signalée par M. Louvel, directeur du service forestier à Madagascar et appelée *Symphonia Louveli* par les mêmes botanistes, Jumelle et Perrier de la Bathie,[4] est constituée par un arbre de 20 à 25 mètres de hauteur, à tronc droit, dont la résine, d'abord jaune, devient brune, à feuilles petites et coriaces, à fruits volumineux (16 centim. sur 10) présentant cinq côtes arrondies et renferment environ quatre graines.

Ce sont les graines de ces deux espèces de *Symphonia* qui nous ont été communiquées par M. Jumelle, pour en faire l'étude chimique.

2° Ces graines ont été broyées au moulin et épuisées par la benzine; par évaporation de ce solvant, on a obtenu : —

Pour le *Symphonia lævis*	...	35·2 p. cent de matière grasse
Pour le *Symphonia Louveli*	...	40·0 ,, ,, ,,

Les tourteaux restants après dessiccation, possédaient, dans les deux cas, une texture fibreuse qui doit les rendre désagreables à manger pour les animaux; ils présentaient les compositions centésimales suivantes : —

	S. lævis.	S. Louveli.
Cendres	5·50	4·50
Matières azotées	8·73	10·50
Sucres réducteurs	9·06	4·43
Sucres non réducteurs	0·91	1·27
Tannins, acides végétaux, etc. ...	2·62	4·85
Cellulose	32·00	27·65
Gommes hydrolysables, xylane ...	26·18	28·80
Amidon	néant	néant
Vasculose	15·00	18·00
Total	100·00	100·00

Ces tourteaux, de composition assez voisine, sont,

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[4] "*Symphonia* à graines grasses de l'Est de Madagascar," H. Jumelle et H. Perrier de la Bathie, *L'Agriculture pratique des Pays chauds*, Challamel, éditeur, 1913.

somme toute, peu riches en matières azotées et même en hydrates de carbone assimilables; ils pourraient en tous cas servir d'engrais.

Les matières grasses obtenues avec les deux espèces de *Symphonia* sont de consistance pâteuse, jaune foncé, présentant l'odeur habituelle des substances grasses; elles possèdent les constantes suivantes:—

	S. lævis.		S. Louveli.
Densité a 20°	0·872	...	0·879
Point de fusion	15-16°	...	15-16°
Indice d'acidité	8·4	...	8·4
,, de saponification	189	...	189
,, de Reichert (ac. gras volatils) ...	1·65	...	1·65
,, d'Hehner (ac. gras insolubles)...	94·3	...	94·1
,, d'iode (ac. gras non saturés) ...	66·7	...	67·6
Point de fusion des acides gras ...	42·5°	...	43°

L'identité de ces résultats permettrait de conclure à celle des huiles obtenues avec les deux espèces de *Symphonia* que nous avons examinées. En tous cas, pour confirmer ce point et pour chercher à déterminer la composition immédiate de ces matières grasses, nous avons effectué la séparation de leurs acides gras saturés et non saturés par épuisement de leurs sels de plomb à l'éther, qui dissout seulement ceux des acides non saturés; nous avons trouvé pour la proportion des deux sortes d'acides:—

	S. lævis.		S. Louveli.
Acides gras saturés ...	40 p. cent	...	35 p. cent
,, ,, non saturés ...	60 ,,	...	65 ,,

Les acides saturés fondaient, pour les deux espèces, à 55°; les acides non saturés étaient liquides, jaunes et leur majeure partie doit être formée d'acide oléique, car on a pu les transformer en grande proportion, par l'action du nitrate acide de mercure, en acide élaïdique.

Les acides gras saturés, solides, ont été fractionnés par deux précipitations successives à l'acétate de baryum; les acides gras, régénérés de ces deux portions, fondaient aux températures suivantes:—

	S. lævis.		S. Louveli.
1re précipitation	60°	...	65°
2e ,, ...	39	...	36

Leurs sels de baryum ont donné à l'analyse : —

	Baryum pour cent.			
	S. lævis.	S. Louveli.	Calculé pour :	
1re précipitation ...	18·4 ...	25·2	$(C_{10}H_{19}O_2)_2Ba$ ...	28·8
			$(C_{12}H_{23}O_2)_2Ba$ ...	25·7
2e ,, ...	29·4 ...	28·4	$(C_{17}H_{33}O_2)_2Ba$ ...	20·3
			$(C_{20}H_{39}O_2)_2Ba$ ...	18·1

Dans le cas du *Symphonia lævis*, il semblerait que la première portion corresponde à un mélange d'acides en C_{17} et C_{20}, margarique et arachidique, fondant respectivement à 60° et 75° et la seconde à un mélange d'acides en C_{12} et C_{10}, laurique et caprique fondant à 43·6° et 30°. Dans le cas du *Symphonia Louveli*, la première précipitation paraît se rapporter aux acides margarique et arachidique mélangés d'un peu d'acide laurique, et la seconde aux acides laurique et caprique. Somme toute, ces différentes déterminations tendraient à confirmer la ressemblance ou l'identité des graisses des deux espèces de *Symphonia* et démontreraient leur emploi possible pour la savonnerie à cause de la forte proportion d'acides liquides qu'elles renferment, et pour la stéarinerie en raison du point de fusion assez élevé de leurs acides gras solides.

LES EXIGENCES DE L'INDUSTRIE METROPOLITAINE EN MATIERES GRASSES DES COLONIES ET PAYS TROPICAUX.

Par M. Alexandre Hébert.

1° Les besoins et la consommation de l'industrie métropolitaine augmente constamment depuis un certain nombre d'années. Les différents emplois qu'on en fait justifient en effet cette augmentation.

Tout d'abord, l'alimentation utilise une très-grande proportion de matières grasses. Ces substances sont nécessaires surtout dans les pays du Nord par suite de leur chaleur de combustion élevée, qui entretient plus facilement la chaleur animale. En effet, tandis que chaque kilogramme de substances alimentaires hydrocarbonées ou albuminoïdes fournit seulement 4·1 grandes calories à l'organisme, la même quantité de matières grasses lui en apporte 9·3 grandes calories. Les habitants des pays septentrionaux ont donc tout intérêt à charger leur alimentation en corps gras pour entretenir dans de justes limites leur chaleur animale.

Dans ces pays, d'ailleurs, ces substances alimentaires étaient fournies par des matières d'origine animale: le beurre, le saindoux, les graisses de bœuf, de mouton, de diffèrents animaux en faisaient les frais. Mais ces matières, et notamment le beurre, sont d'un prix assez élevé et viennent grever fortement le budget des familles modestes ou ouvrières. Aussi depuis quelques années a-t-on cherché avec succès à les remplacer par des graisses, tirées du regne vegétal et provenant à peu près uniquement des produits exotiques coloniaux; la végétaline, la cocose, etc., sont les plus connues de ces succédanes qui peuvent être obtenus dans des conditions économiques supèrieures à celles des graisses d'origine animale, et qui se répandent de plus en plus dans les classes moyennes ou pauvres. Dans les contrées méridionales, au lieu d'employer à l'alimentation des matières grasses solides à la température ordinaire, on se sert d'huiles, dont le type était constitué par l'huile d'olive. Là encore, la consommation a tendance à se développer plus vite que la production, et l'on a eu également recours à divers produits oléagineux coloniaux, de constitution aussi rapprochée que possible de celle de l'huile d'olive, et qui ont aussi, de plus, l'avantage d'être d'un prix moins élevé. En dehors de l'alimentation, les matières grasses sont employées également en grandes quantités à un certain nombre d'autres usages des plus importants. La stéarinerie et la fabrication des bougies exigent des matières grasses contenant surtout des acides à point de fusion élevé. On employait surtout dans ce but des graisses animales; mais le prix relativement élevé de celles-ci, d'une part; d'autre part l'usage qu'on en a fait au point de vue alimentaire, en a restreint l'emploi dans la stéarinerie et a conduit cette industrie à rechercher dans les produits végétaux les matières premières dont elle avait besoin. Cet emploi tend à se généraliser à la suite de la découverte récente de l'hydrogénation et par suite de la solidification des huiles dont nous parlerons tout à l'heure. La consommation des produits de la stéarinerie ne cesse d'ailleurs de s'accroitre, malgré les perfectionnements incessants des autres modes d'éclairage: pétrole, gaz, électricité, et elle constitue une branche très-développée de l'utilisation des matières grasses.

Nous devons faire des constatations analogues en ce qui concerne la savonnerie. A mesure que l'hygiène et le bien-être public s'accroissent, l'emploi des savons augmente de plus en plus et les matières premières qui, auparavant, provenaient seulement de la métropole, ont besoin actuellement du concours que leur apportent les graisses exotiques. Cette industrie mettait d'abord volontiers en œuvre les résidus, en quelque sorte, de la stéarinerie, c'est à dire les acides liquides qui provenaient de l'extraction de la stéarine; mais ces matières maintenant sont loin de lui suffire et elle est également obligée de mettre à contribution les productions coloniales, sous forme des nombreuses sortes d'huiles ou graisses oléagineuses importées en Europe.

Par contre, l'emploi des huiles et des graisses comme lubrifiants, comme produits de graissage pour les organes des machines tend plutôt à se réduire par suite de l'introduction pour cet usage des huiles de vaseline et des vaselines d'origine universale. Ces derniers produits présentent sur les matières grasses l'avantage de ne pas s'oxyder, et par suite de ne pas s'acidifier et de beaucoup moins s'altérer, ce qui est tout profit au point de vue de la conservation des organes mécaniques qui en sont garnis. En tous cas, pour cet usage les substances grasses doivent renfermer le minimum d'acides incomplets pour éviter autant que possible cette oxydation et les inconvénients qui en résultent.

C'est le contraire que l'on doit rechercher pour les produits oléagineux destinés à la fabrication des vernis. En effet, dans ce but, on a intérêt à porter la siccativité, c'est-à-dire l'oxydation, de l'huile au plus haut point; cette oxydation peut être accélérée en chauffant l'huile au contact de divers oxydants: l'air, la litharge, le peroxide de manganèse, le sous-acétate ou l'oléate de plomb, le borate ou l'oxalate de manganèse, le plomb divisé en poudre fine, etc. La plupart des huiles, et notamment celles qui contiennent la plus grande quantité d'acides incomplets, perdent dans ces conditions leur liquidité, s'epaississent et se transforment en corps résinoïdes insolubles dans l'alcool et dans l'éther. Le type de ces huiles est l'huile de lin qui est tirée de nos régions; mais elle est concurrencée depuis longtemps par un certain nombre de substances oléagineuses d'une siccativité au moins égale, et de provenance coloniale.

On voit qu'un certain nombre d'emplois exigent des matières grasses d'une certaine consistance et d'un point de fusion assez élevé, sans compter que sous la forme solide les substances oléagineuses sont naturellement d'un transport beaucoup plus facile. Or un des principaux inconvénients des graisses exotiques ou coloniales consiste dans l'état liquide qu'elles possèdent souvent et qui empêche ou gène leur emploi dans un certain nombre de cas: pour l'alimentation, la stéarinerie, la fabrication des savons durs. Cet inconvénient est maintenant supprimé grâce au procédé d'hydrogénation ou de solidification des huiles, par fixation d'hydrogène sous pression en présence d'un catalyseur quelconque, dont un certain nombre—nickel, platine, palladium—ont fait leurs preuves; les difficultés de préparation de l'hydrogène pur nécessaire à ces opérations ayant pu être surmontées, grâce aux progrès de l'aéronautique.

Les produits hydrogénés ainsi obtenus peuvent parfaitement servir à fabriquer les savons durs; mais leur emploi en stéarinerie est encore discuté, car leur hydrogénation et leur transformation en produits saturés n'est pas absolument intégrale. De même leur emploi pour l'alimentation est également discuté, car on craint que le produit transformé ne retienne des traces du catalyseur, et bien que les matières employées dans ce but passent généralement pour non nocives; les esprits sensorés redoutent toujours une certaine action toxique à plus ou moins longue échéance.

Ces procédés d'hydrogénation ont un autre avantage: c'est qu'en même temps que l'amélioration de l'huile, ils provoquent sa désodorisation; c'est ainsi que l'huile de poisson sort absolument inodore des appareils d'hydrogénation. Toutes ces modifications ont l'avantage de donner au produit transformé un supplément de valeur qui paye au-delà les frais engagés pour réaliser l'hydrogénation et laisse un bénéfice des plus appréciables.

2° Ayant passé en revue rapidement les divers emplois qui nécessitent l'usage des matières grasses et les désiderata à réaliser pour chacun de ces emplois, il est intéressant de suivre le mouvement de ces mêmes substances grasses.

Le tableau suivant, dressé d'après les documents du "Tableau général du Commerce et de la Navigation de 1911," indique en regard des produits les principaux pays de destination avec les chiffres exprimant les exportations en quintaux métriques; il peut fournir des indications sur les besoins réciproques des divers pays.

PRINCIPALES DESTINATIONS.

Huile fixe pure d'olive	Etats-Unis, 17,089 quintaux.
Huile de palme	Italie, 9,010.
Huiles fixes pures de coco, de toulloucouna, d'illipe et de palmiste	Angleterre, 60,008; Suisse, 27,749; Etats-Unis, 26,890.
Huiles fixes pures de ricin et de pulghère	Turquie, 3,070; Autriche-Hongrie, 3,008; Angleterre, 3,004; Allemagne, 3,001.

PRINCIPALES DESTINATIONS—(*Continued*).

Huile fixe pure de lin	Angleterre, 13,903.
Huile de coton	Pays-bas, 726.
Huile de sésame	Suisse, 19,516; Italie, 17,678.
Huile d'arachide	Algérie, 43,017; Italie, 42,068; Angleterre, 18,776; Etats-Unis, 18,140; Suisse, 13,644.
Huile de colza	Etats-Unis, 3,307; Belgique, 3,145; Angleterre, 2,572.
Huile d'œillette	Belgique, 7,364.
Huiles autres qu'œillette, pavot et de navette	Suisse, 2,360; Belgique, 2,360.

PRINCIPAUX PAYS DE PROVENANCE.

Huile d'olive	Espagne, 32,255; Italie, 20,817.
Huile de palme	Côte occidental de l'Afrique française, 147,469.
Huiles de coco, de touloucouna, d'illipe et de palmiste	Belgique, 6,440.
Huile de ricin	Angleterre, 5,853.
Huile de lin	Angleterre, 3,104; Pays-bas, 2,689.
Huile de coton	Etats-Unis, 186,681.

On peut se sendre compte par ces chiffres du mouvement qui se dessine depuis quelques années; les pays européens et les Etats-Unis recevant de grandes quantités de matières grasses dont une forte proportion est fournie par les colonies.

La progression du mouvement commercial occasioné par les matières grasses en ce qui concerne notre pays est bien mise en valeur par le tableau suivant extrait des chiffres fournis par le rapport pour la section française de l'Exposition universelle de Bruxelles de 1910.

TABLEAU COMPARATIF DES EXPORTATIONS ET IMPORTATIONS DES MATIÈRES GRASSES (COMMERCE SPÉCIAL).

Désignation des produits	Exportations		Importations	
	1900	1909	1900	1909
	Fr.	Fr.	Fr.	Fr.
Huile fixe pure d'olive	3,870,000	10,128,000	8,308,000	15,350,000
,, ,, de palme ...	129,000	990,000	7,562,000	41,278,000
,, de coco, touloucouna, illipé, palmiste	4,699,000	15,836,000	335,000	791,000
Huile de ricin et de pulghère	2,488,000	2,245,000	1,800	514,090
Huile fixe pure de lin	1,234,000	2,537,000	111,000	647,000
,, de coton ...	729,000	2,083,000	19,119,000	16,664,000
,, de sésame ...	5,648,000	8,624,000	—	—
,, d'arachides ...	1,985,000	11,831,000	—	—
,, de colza ...	1,560,000	1,249,000	—	—
,, d'œillette ...	896,000	962,000	—	—

3° Ces chiffres manifestent le besoin croissant de l'industrie métropolitaine en matières grasses. Or, on peut constater que nos pays européens, que la France notamment, tend à ne plus développer sa production de substances grasses ou mieux des graines oléagineuses dont le traitement fournit ces substances grasses. La culture de l'olive tend fortement à emigrer de l'autre côté de la Méditerranée, en Algérie et en Tunisie; le lin, l'œillette, le colza voient tous les ans diminuer les surfaces culturales qui leur étaient consacrées et ou les remplace de plus en plus par d'autres cultures, qu'à tort ou à raison on juge plus rémunératrices.

Le besoin des matières grasses croissant et la production des graines oléagineuses diminuant dans nos pays, on devra forcément se procurer ailleurs ces matières premières qui tendent à faire défaut. Déjà de très-grandes quantités de matières grasses sont fournis par les colonies et les pays tropicaux; il conviendra donc de développer ces sources pour fournir aux besoins de la métropole; et pour le faire à bon escient il faudra d'abord bien connaitre les substances grasses exotiques. Un assez grand nombre sont déjà connues et entrent pour une grande part dans notre approvisionnement. C'est là un point de vue qu'il y a lieu de développer, ainsi que l'ont fait d'ailleurs plusieurs autres contrées.

THE FERTILITY OF SOILS IN THE TROPICS.

SOME NOTES ON CERTAIN POINTS IN RELATION TO THE PROBLEM OF SOIL FERTILITY IN THE TROPICS.

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During recent years considerable attention has been directed to the problem of soil fertility, the last decade having been productive of a number of important additions to knowledge in this connection; of especial significance has been the prominence which biological factors have assumed in relation to the question. The results have, however, been attained under temperate conditions, and up to the present time no special attention has been directed to the aspects presented in this connection by soils in tropical countries.

In temperate climates the biological activities of the soil are of necessity limited to a marked extent by the relatively large annual temperature range; during the spring, summer, and early autumn the processes in question attain their maximum energy, but the intervention every year of a winter period during which activity in this direction is very greatly reduced, if not entirely suspended at times, constitutes a limiting factor of prime importance; the natural sequence of events under these conditions is therefore that of an alternation of periods of great and small biological activity which grade one into the other with the advance of the seasons.

In the tropics, on the other hand, the natural state of affairs differs markedly from the foregoing; the absence of a well-marked period of cold weather, except in a minor degree, which is characteristic of a great number of localities, combined with a set of conditions which in other respects are particularly favourable to biological development, serve greatly to enhance the importance of this factor; indeed, it may be suggested that under the conditions in question relationships of this description play a part the importance of which cannot be overstated.

It is perhaps the natural outcome of the fact that up to the present the work of tropical agricultural departments has been more especially concerned with questions affecting the development of agricultural industries and the investigation of problems cognate to them, that the special aspects of soil fertility in the tropics have not been more fully investigated. In many instances, moreover, the lands which are being worked have been but recently introduced into cultivation and possess relatively large accumulations of fertility. Under these circumstances the practical problem which immediately presents itself for solution is the manner in which these accumulations may be used up to the best advantage. There are in some countries, it is true, considerable tracts of land which have been under cultivation for long periods of time, and under these conditions intensive systems of agriculture have in many instances become evolved. This is particularly the case when, as in some of the West Indian islands, the total area of cultivable land is limited; it is significant that under these conditions the system of agriculture which has evolved itself has for its basis the relatively frequent application of organic manures, sometimes supplemented by various artificial manures.

A certain amount of preliminary investigation has been carried out by the Agricultural Department in the Leeward Islands during the years 1912 and 1913, in relation to some of the more important conditions under which soils in that colony exist. The detailed results of this work have been published in the *West Indian Bulletin*, vol. xiv (1914), pp. 146-152; in the present paper it will suffice to indicate the general character of the results obtained.

The scope of the investigations has included measurements of soil temperature and soil moisture, measurements of the rate of decay of soil organic matter as the result of bacterial action; the investigation of the process of nitrification in soils and also of the fixation of free atmospheric nitrogen as the result of the action of bacteria of the Azotobacter type.

In relation to soil temperature, a large number of measurements have been performed at varying times and seasons throughout the year, at elevations ranging between 100 ft. and 2,000 ft. above sea-level, and in soil types varying between light sandy soils and heavy clays; in all cases the measurements were made at depths of 6 in., 12 in., and 18 in. respectively. The results generally show a series of values ranging between 20° C. and 30° C.; in the whole course of the measurements no value below 20° C. was recorded, while this was only attained at considerable elevations in the very early morning during the cool season. The upper value of 30° C. was occasionally slightly exceeded in the case of the upper 6 in. of soils of light texture exposed to the direct rays of the sun during the hottest portions of the day. No doubt higher values than this are reached in the uppermost layers, *i.e.*, the top one or two inches, but the temperature gradient from the topmost layer down to those levels at which the root systems of plants normally exist, appears to be very steep during the day. As is to be expected, the actual daily range of temperature is least at the lowest point at which the measurements were made, and more equable temperatures were experienced throughout in the case of orchard soils in which the surface is shaded from the direct rays of the sun. It will be seen that the actual range of temperature experienced is particularly favourable to the growth of organisms and that, with the possible exception of the top two inches of soil, at no time is a value attained which is likely to check development to any marked extent.

A limiting factor which may occur in the case of arid and semi-arid regions lies in the water supply, but under the conditions governing our observations the soil moisture content never falls so low as entirely to check the growth of organisms, while in wetter localities it is usually maintained in a condition highly conducive to biological activity. On the whole it may be said that though the alternations of wet and dry seasons probably affect the biological activities of soils in the tropics to quite an appreciable extent, such variations will depend for their magnitude on local conditions, and in any case will contrast markedly with the regular rise and fall in activity characteristic of soils in temperate regions.

In relation to the rate at which organic matter tends to decay as the result of bacterial activity, the result of our investigations may be summarized by saying that as the outcome of thirteen separate sets of measurements on soils from different localities, both *in situ* and also on samples under laboratory conditions, it was found that in periods varying between six and twelve months the content of organic matter became reduced by amounts ranging between 12 and 30 per cent. of the total originally present. The effect of organic matter on the physical and mechanical characters and properties of soils has for long been understood and appreciated; of more recent date is the apprehension of the functions exercised by it in relation to the supply of energy for the maintenance of various important bacterial reactions; chief among these may be cited the putrefactive processes resulting under suitable conditions in the liberation of a constant supply of carbon dioxide which assists in rendering available the locked up stores of plant food in the soil.

Of importance also appear to be those organisms which are responsible for the fixation of atmospheric nitrogen without the intervention of leguminous host plants, notably those comprised in the Azotobacter group. The existence of organisms of this type has been demonstrated in soils throughout the Leeward Islands and their activity in fixing nitrogen measured approximately in a number of instances.

A study of the soil conditions obtaining on plots of cacao in the Dominica Botanic Gardens, comprising a set of manurial experiments in which each unit has received the same manurial treatment for the past twelve years continuously, has shown that on those plots which have received moderately heavy dressings of organic manure considerable accretions of nitrogen have taken place in the soil in excess of that which has been added in the manure. The only satisfactory explanation of this result appears to lie in the assumption that it is occasioned by the operations of organisms of the Azotobacter type, the existence of which has been demonstrated in the soils in question.

Results in connection with the soils of these same plots are also available to show that in the cases where moderately heavy dressings of organic manures have been applied the rate of decay of organic matter is more rapid than when such manures have been withheld, affording additional evidence that liberal applications of organic manure result in an increase in numbers and vigour of the bacterial flora.

In relation to nitrifying power, all of the soils examined showed normal properties; it is, however, again significant that those soils which have been manured with organic manures gave higher values for this property as a general rule. A point of interest in this connection is that though many of the soils in question are naturally deficient in lime they still showed marked formation of nitrates under laboratory conditions; the suggestion has been made that perhaps under these circumstances ammonia formed in the course of ammonification may function as a base for the neutralization of nitric acid, though no experimental evidence is as yet available in favour of this view.

A considerable range of manurial experiments in the Leeward Islands over a period of fifteen years' duration has fully confirmed the view that the most satisfactory way of maintaining fertility lies in the application of organic manures. A result such as this sheds important confirmatory evidence on the views outlined above.

It is submitted that the above results taken with the indications of manurial experiments, both in the Leeward Islands and elsewhere, point definitely to the importance of maintaining the supply of organic matter in tropical soils; if this is withheld diminution in fertility takes place owing to the effect on the biological relationships which ensue.

There would further appear reason to believe that the accumulation of organic matter affords an explanation of the high fertility typical of newly cleared forest land in the tropics, since considerable accumulations of nitrogen are apparently likely to take place as the result of the action of nitrogen-fixing bacteria, while the reserves of other plant foods remain undepleted.

The question of the relationships existing between the content of organic matter, the bacterial population, and the fertility of tropical soils is of considerable interest; owing to the high and equable temperature the various processes are enabled to proceed with much greater regularity and at a much higher speed than under temperate conditions. Considerations such as these indicate that the tropics present special facilities for the study of certain soil problems and it would seem that the further investigation of the subject would be likely to yield information of value and facilitate the elucidation of important points which are at present obscure.

FERTILITY SURVEY OF THE EGYPTIAN DELTA.

By B. F. E. Keeling, M.A.

Director of Physical Services, Survey Department, Ministry of Finance, Egypt.

The Egyptian Government is at present engaged on improving radically the drainage of the lower-lying parts of the Delta, and it was decided to make a detailed survey of these areas which would record the present condition of the land. The survey has a two-fold object. Firstly, such a survey will give the authorities considerable assistance in laying out the details of their drainage plans, and secondly, after the new drains and pumps have been at work for some years it will be possible to assess the improvement effected in different localities.

It is eventually hoped to improve the drainage of the whole country, but naturally this can only be done by degrees, and the first areas to be dealt with are the central part of the Delta and the most western portion draining into Lake Mariut, and accordingly these two areas have been surveyed.

The procedure adopted is as follows:—

The field parties are provided with maps on the scale of 1 : 10,000 on which the boundaries of all the ownership plots are marked. The surveyor takes this map and crosses and re-crosses the land shown upon it, marking on the map his opinion of the value of the land. Five categories of land are recognized—good, medium, bad, uncultivated and under reclamation. On the field-sheets certain other information is recorded, in particular on the uncultivated land notes are made if large quantities of grass or bush are present.

There is, of course, no hard-and-fast line between the first three categories of good, medium and bad, and in particular the first two overlap, the quality often depending on other than natural causes, such as good or bad cultivation, use or absence of manures and the like.

Experience has shown, however, that an independent person taking the field-sheet over the country will rarely disagree with the opinion formed, and that in particular there will be no difference of opinion that the good land is not bad, and the bad not good. For contiguous classes, good and medium, medium and bad, there is, of course, no sharply defined boundary and opinion will occasionally differ as to which class the land should be assigned to.

A check, however, was put from the outset on the scale adopted by the field observers. It is well recognized that the principal determining factor in the fertility of the Delta land is the presence or absence of soluble salts. If salts are absent good crops can be obtained, if much salt is present it is impossible to grow crops. Accordingly from the outset of the survey it was arranged that frequent soil samples should be taken and that the total soluble salts contained in these should be determined.

The laboratory work was in charge of Mr. Hughes. The rule laid down was that on each 1 : 10,000 sheet five samples should be taken from plots of each quality, good, medium, bad and barren. When on a sheet there was only a small area of a particular category the number of samples was suitably reduced. The amount of salt was determined by dissolving out the salt from 5 grams of the sample in 100 c.c. of water and determining the electric resistance of the solution in a suitable Wheatstone's bridge. A curve had previously been drawn showing the relation between the electric resistance and the salt content of solutions of different strengths and from this curve the salt content of the samples from the field could be read off. In the case of very salty soils, the solution has to be further diluted before making the determination.

The results of these analyses show that the fertility survey is in fact a close approximation to a salt survey by eye estimation.

The mean salt-content of what we have called good land is about 0·3 per cent., of medium land about 0·5 per cent., and of poor land about 0·8 per cent. The barren land may contain any amount of salt up to 25 per cent. The Biala Colony of 500 feddans contained before washing an average of 10 per cent. of salt.

In the more northern parts of the Delta all the samples were also examined for sodium carbonate and bicarbonate which in certain areas are present in considerable quantities. The sodium carbonate is of great importance as its presence adds very greatly to the cost of land reclamation, a small quantity rendering the land impervious to water. A detailed survey of certain carbonate areas of Government land was made with a view to watching the effect of treatment with gypsum.

The field-sheets when they come in are reduced to the scale of 1 : 50,000 to obtain a more convenient map for ready reference. The original sheets will, of course, be stored and will be available in years to come for comparison with the improved condition of the land which it is hoped will be the outcome of the drainage works.

A reference to the fertility map of the Central Delta[1] shows the gradual transition from good land in the south, through medium land to bad land, with large areas of barren land in the north, and it will be seen what a large amount of improvement has to be effected before the whole area becomes good or medium land. It is also interesting to note the close dependence of the fertility on the altitude above sea-level, or, in other words, on the natural drainage.

The contoured map[1] on the same scale as the fertility map shows that the general division between good and medium land follows roughly the 6-metre contour, whilst the division between bad and barren lies somewhere near the 5-metre contour. This is true in general and also in particular. The area of the good land to the north of Belqâs is an example. Reference to the contoured map shows that there is here a hog's back with an altitude of less than one metre with the Bahr Belqâs

[1] Not reproduced.

running along the top. The same phenomenon is shown by strips of good land running along the large feeder, the Bahr Shebin, which, following the usual Delta rule, is higher than the surrounding country.

This relationship is of course well known, and is strikingly exemplified by another map,[1] which is a general fertility map representing the mean rate at which the land was taxed in the year 1907, including both permanent and temporary taxes. This shows the dependence of fertility on altitude. In the Delta the land always slopes away from the river and accordingly the land tends to be best along the river branches. Great tongues of good land spread on both sides down each branch of the river as it is now, and also down the lines of the two great branches of ancient times.

This map is almost an exact duplicate of the contoured map.

Artificial drainage, of course, lowers the subsoil water-level, and in the future, when the works are complete, the Delta will in great measure become, from the point of view of its fertility, independent of its altitude above the sea.

[1] Not reproduced.

THE WATER SUPPLY OF EGYPT, 1913-1914.

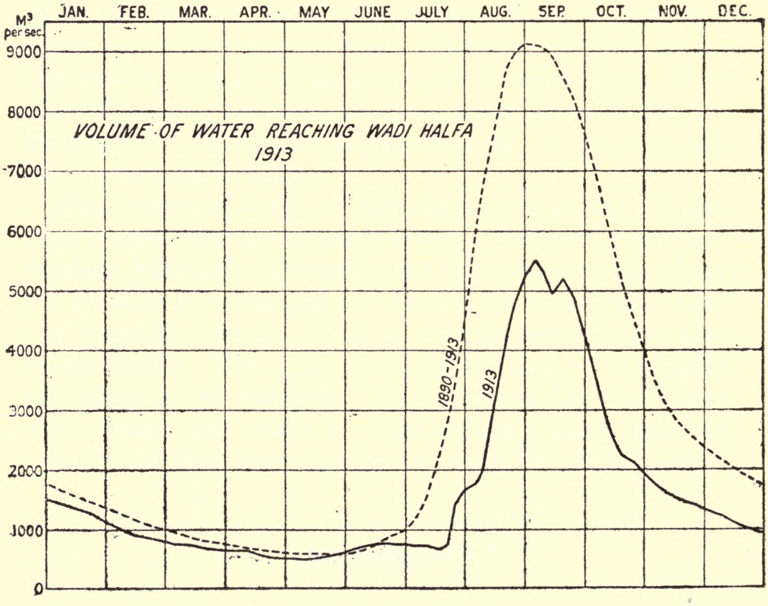
By B. F. E. Keeling, M.A.

Director of Physical Services, Survey Department, Ministry of Finance, Egypt.

The amount of water in the Nile at its entrance to Egypt during the past twelve months has been less than during any previous year on record, and in spite of the heightening of the Aswan dam by which its capacity was more than doubled, the deficiency of water has cost Egypt many millions of pounds. It will not therefore be thought out of place if I describe in its broader aspects the hydrography of the Nile, the variations in which from year to year are mainly responsible for the variation in agri-

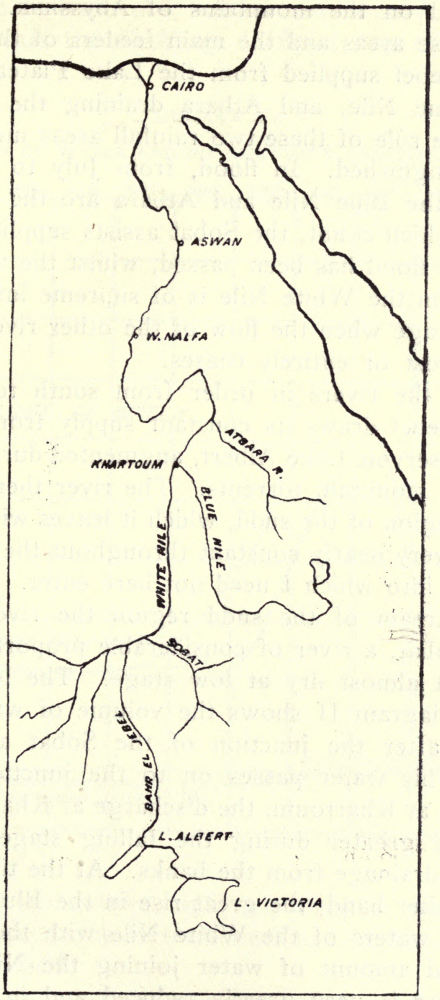
Diagram I.

Volume of Water entering Egypt at Wadi Halfa.



cultural returns. This is clearly represented in the dotted line in Diagram I, which shows the variation in volume during a normal year as the river enters Egypt at Wadi

MAP OF NILE BASIN.



Halfa. It will be seen that during the early months the volume is steadily falling till it reaches a minimum of about 600 cubic metres per second at about the end of May, that during the next two months it rapidly rises to more than twenty times that discharge early in September, after which it begins to fall.

This water, which passes Wadi Halfa, has fallen as rain some six weeks or two months previously on the Lake Plateau, draining into the Nyanzas Victoria and Albert and on the mountains of Abyssinia. The map shows these areas and the main feeders of the Nile, the Bahr el Jebel supplied from the Lake Plateau, and the Sobat, Blue Nile, and Atbara draining the Abyssinian hills. The rôle of these two rainfall areas must be carefully distinguished. In flood, from July to the end of the year the Blue Nile and Atbara are the only water supplies which count, the Sobat assists supplies after the top of the flood has been passed, whilst the water which comes from the White Nile is of supreme importance in the low stage when the flow of the other rivers in many years almost or entirely ceases.

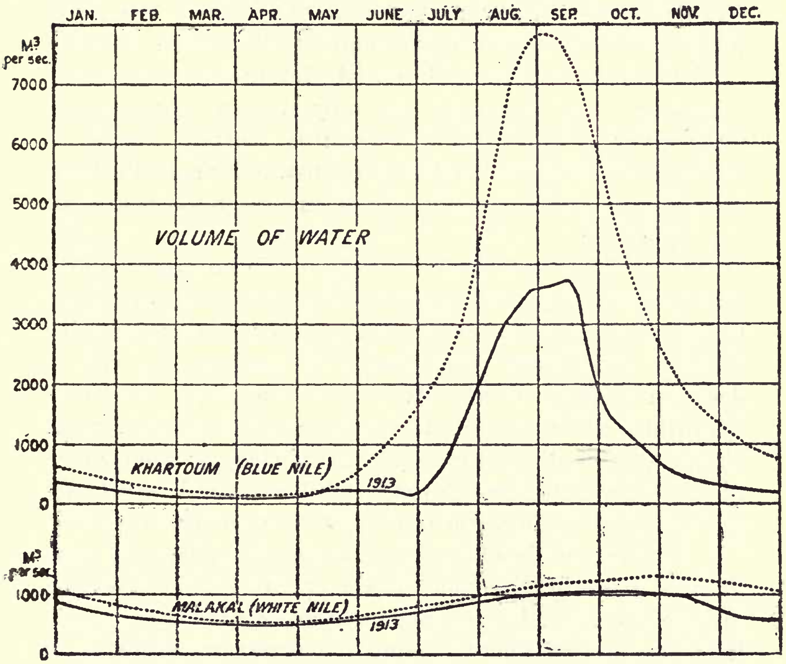
Taking the rivers in order from south to north the Bahr el Jebel draws its constant supply from the great natural reservoir Lake Albert, augmented during flood by numerous mountain torrents. The river then enters the famous region of the sudd, which it leaves with a volume which is very nearly constant throughout the year owing to causes into which I need not here enter.

Downstream of the sudd region the river is joined by the Sobat, a river of considerable proportions during flood, but almost dry at low stage. The lower dotted line in Diagram II shows the volume of water passing Malakal after the junction of the Sobat and Bahr el Jebel. This water passes on to the junction with the Blue Nile at Khartoum, the discharge at Khartoum being somewhat greater during the falling stages owing to gains by drainage from the banks. At the time of flood, on the other hand, the great rise in the Blue Nile holds back the waters of the White Nile with the result that the actual amount of water joining the Nile from the latter river is very greatly reduced and in some years there is probably a net upflow just before the top of the flood with a correspondingly increased downflow when the flood has begun to fall.

The Blue Nile receives its water from the rainfall over a comparatively small area about its upper reaches. The dotted lines in Diagram II show the height and volume of the discharge during an average year. It will be seen that, unlike the White Nile, the Blue Nile has an enormous range, the discharge varying in a normal year from about 8,000 to 100 cubic metres per second, whilst in abnormal years the discharge in flood may reach 12,000

DIAGRAM II.

VOLUME OF WATER PASSING KHARTOUM AND MALAKAL.



cubic metres per second, and may drop at the time of minimum supply in the early summer to as little as 50 cubic metres per second.

As an example of the relative volumes of the river at different times in the year we may take the figures for 1911 as fairly representative of a normal year. The following table gives the percentage contributions of the two rivers to the main Nile at Khartoum.

1911	White Nile	Blue Nile
January	71	29
February	77	23
March	76	24
April	77	23
May	72	28
June	73	27
July	27	73
August	2	98
September	6	94
October	32	68
November	39	61
December	52	48
1912		
January	63	37

This shows clearly that the White Nile is the more important river in low stage, and the Blue Nile in flood.

The waters of the Blue and White Niles meet at Khartoum, and thereafter the only tributary joining the main river is the Atbara, which is entirely dry from October to May, but in July, August and September has a high flood discharge, supplementing the flood waters of the Blue Nile.

Having thus described the origin of the water which makes agriculture in Egypt possible, we are in a position to consider the abnormal character of the last twelve months, but before doing so it will perhaps be well to describe briefly the methods of water supply.

Putting aside minor details, the cultivated area of Egypt may be divided into two great classes: land which receives perennial irrigation, and basin land which receives one watering a year only, at time of flood.

I will describe briefly the former system first. For the greater part of the year the river is flowing several metres below land level, and to give continual irrigation it is necessary either to pump the water from the river to high level canals running through the fields, or to construct barrages across the river to raise the water level artificially to the neighbourhood of land-level. A typical case of the former is the Kom Ombo estate, which depends entirely on pumps for its water supply, whilst the perennially irrigated area of Upper Egypt is dependent for its regular supply at low stage on the Assiut Barrage. This barrage holds up the water-levels by a maximum of about 2 metres, and enables the Ibrahimia Canal to receive a proper supply of water during the low stage. The slope of the water-surface is less than that of the land, and by the time Deirut is reached is above land-level, and watering by free-flow becomes possible. The Delta Barrage fulfils a similar purpose, the canals which water the Delta taking off upstream of it. As a matter of fact the canal system of the Delta is not at present designed to secure free flow to more than a quarter of the Delta, and the water in the canals in the remainder flows below land-level, and has to be pumped through one or two before it can be applied to the land. The main feature of the perennially irrigated area from the point of view of this paper is that its agriculture depends entirely on the quantity of water which is available, and not on the level at which that water is flowing in the river.

It is very different in the case of the basin lands, about a million and a quarter acres in extent, which receive a watering once a year by flooding at the time of high Nile, the only supply at other times of year being that which is obtained from wells. For the supply, canals are dug taking direct from the river and when the river rises they fill. The slope of the water surface in the canal is less than that of the land and some distance below the head the water can be poured on to the land. Theoretically, the greater part of this basin land could be given its flooding even in bad years, but the canal system would be enormously costly and the annual upkeep would be prodigious if years such as the one we have just gone through were to be provided for. If the Nile falls below a proper level the irrigation of the area becomes difficult and in years such as 1913-1914 it becomes impossible to provide water to large stretches of country.

The approximate amount of water required (in millions of cubic metres per day) during the summer when there is a deficiency of supplies in the natural river is shown in the table below:—

	Water required	Water entering Egypt at Halfa	Excess	Deficiency
March	50	77	27	—
April	65	60	—	5
May	55	52	—	3
June	65	65	—	—
July (1-15)	70	110	40	—

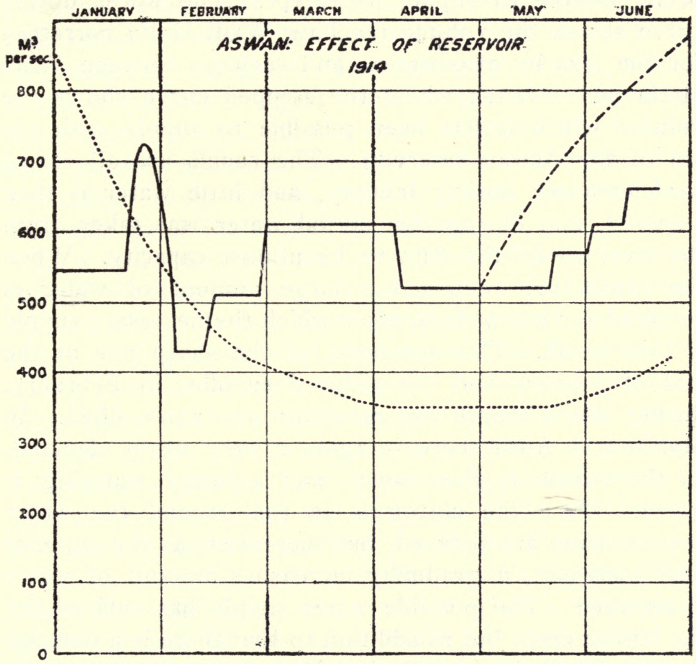
Thus it will be seen that the period of deficiency in a normal year is practically confined to April and May. Seepage from the banks, the amount of which is at present rather uncertain, helps to reduce the deficiency and a certain amount of water is obtained from wells driven into the subsoil, but the main portion of the deficiency is made good by the storage water of the Aswan dam. In normal years, and years of good low supply, the natural river is nearly and sometimes quite sufficient for the present area of cultivation, but when the river is below normal the cotton crop depends on the additional supplies from the reservoir, which in extreme years like the present is indeed of insufficient capacity.

Turning now to the last eighteen months, the flood of 1912 was low, but thanks to the increased height of the Aswan dam the quantity of water during the early summer was not worse than in previous years. Early in April, the river at Roseires began to rise rapidly and it was thought by many that the flood was to be an early one. But on May 10 the Blue Nile began to fall rapidly, and at the end of June the river was almost at its lowest for the year, with the result that the real rise did not begin to reach Halfa until July 20. In consequence, until late into July the natural supplies had to be supplemented by water from the reservoir. The false or spring rise which in some years anticipates the true flood is meteorologically independent of the latter, and we may have years in which good spring rains are followed by low flood rains, or vice versa. In 1913, whilst the spring rise was above normal, the flood was the worst for more than a century. The actual volume of the flood was less than half that of an average year. But what is the more correct way of looking at it is the river level at Aswan did not rise above 90 metres and fell away very rapidly. The result was that in many cases it was impossible to fill the basins, and in others water was only kept on for a much shorter time than usual. In all, about 400,000 feddans either were without water entirely, or received a very inadequate supply.

Owing to the difficulty of irrigating Kena Province in low floods, a barrage was constructed some years ago at Esna by means of which flood levels upstream of it can be increased by 2 metres. In 1913, to save as much land as possible, the irrigation authorities held up the water to a higher head than the barrage was designed for. The scour due to the increased head of water was tremendous and great quantities of stone had to be

DIAGRAM III.

AMOUNT OF WATER SUPPLIED TO EGYPT BY ASWAN RESERVOIR.



——— Water supplied by aid of Aswan Reservoir.

...... Volume of water reaching Wadi Halfa, corrected for loss by evaporation and seepage between Wadi Halfa and Aswan.

—·—·— Water required to irrigate rice area.

thrown into the holes which formed downstream of the barrage. By the artificial increase of head obtained, irrigation was saved to hundreds of thousands of feddans which otherwise would have gone waterless, and some further land was flooded by means of the pumps at Nag Hamadi and Baliana, but even so there was a very large area which the flood-waters did not reach.

After the top of the flood all the feeder rivers fell away rapidly, and it was early seen that the water supply during the summer of 1914 would be very short, particularly if the spring rain should fail. To provide the maximum amount of water the overflow sluices of the Aswan dam were boarded up and the volume of the reservoir was increased by about 150 million cubic metres, or roughly 6 per cent.

Diagram III shows the amount of water which it has been possible to supply to Egypt. The lower dotted curve shows the volume reaching Wadi Halfa corrected for the loss by evaporation and seepage between Wadi Halfa and Aswan; whilst the stepped curve shows the volume which it has been possible to supply with the aid of the Aswan reservoir. The canals are all closed for clearances during January, and little water is then required, and during this period water was taken from the river to fill the dam to its utmost capacity. When the canals are reopened a large amount of water is required for a few days, after which the necessary supply is then small. This accounts for the sharp rise at the end of January and the reduced supplies in February, during which month the reservoir was again filled. In March and April there is again a very heavy demand, as the cotton is then sown, and a heavy watering is given. Once the cotton is in the ground the water requirements are reduced, but thereafter, as the summer heat increases, a gradually increasing amount of water is required. The possible water supply has sufficed for the cotton crop, but in addition to that there is a demand for rice which is sown during May.

In a normal year, the area in Lower Egypt under cotton is 1,600,000 feddans, and under rice 230,000 feddans. Rice requires about three times as much water as cotton, about 70 cubic metres per acre per day, against 22 cubic metres, so that with rice the Delta requires 48 million cubic metres a day, whilst without it 32 millions a day suffice.

To provide the rice area with water a further 200 cubic metres per second are required, which would have necessitated the Aswan discharge curve taking the form shown in the upper dotted line. It was obvious at an early date that it was impossible to secure such a supply, and accordingly the cultivation of rice was prohibited, with the result that instead of being starved the cotton crop has received a proper measure of water.

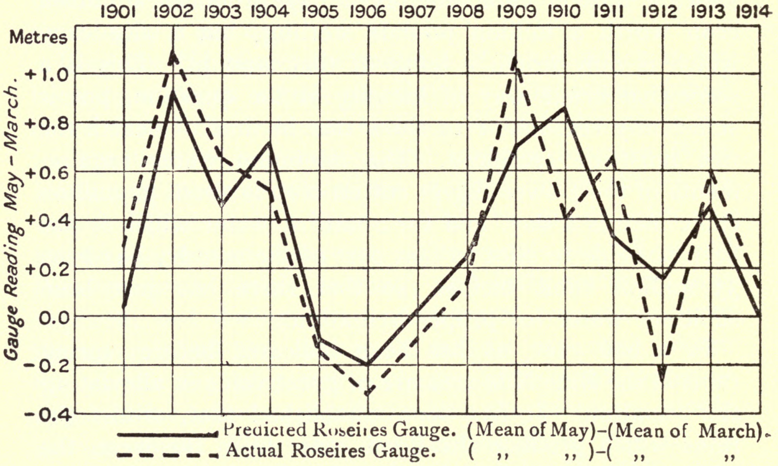
Looking at the question from the financial point of view, a million cubic metres a day produces a cotton crop worth a million pounds sterling, but a rice crop which is only worth a tenth of that amount. This is a somewhat crude way of looking at the question, but is sufficiently reasonable to show that in time of dearth the rice must be sacrificed. The minimum water requirements of the Lower Egypt cotton crop is about 32 million cubic metres a day, and the share of water which it has been possible to allot to that part of the country has been 33 million cubic metres, so that there has just been sufficient water for proper irrigation.

In a bad year, as has been indicated before, spring rains in the Blue Nile area are of great value in alleviating the situation. It has been established that, whilst the rains which produce the flood come from the west, the spring rains come from the east. In view of the great importance of these rains, an investigation was carried out during the past winter to see whether a statistical connection could be found between the variations in the intensity of these rains and variations in the meteorology of places in and surrounding the Indian Ocean.

It was found by analysis of the records for the fifteen years for which they are available, that a surprisingly good forecast of the rains could be made about six weeks ahead. As a measure of the rains the rise in level of the river at Roseires from March to May is taken, and the full line in Diagram IV shows the actual rise, whilst the dotted line indicates the rise computed from the meteorology of the Indian Ocean in March. It will be seen that the agreement is on the whole very good. On the receipt of telegraphic information at the beginning of April, it was disappointing to find that the meteorological indications were that the spring rains would be very weak, the forecasted level at Roseires being nearly a metre below normal. In the middle of April there was a substantial rise, and for a time it appeared as though our forecast was to be wrong, but the rise was of very short duration, and at the beginning of May

DIAGRAM IV.

FORECAST OF THE SPRING RAINS.



levels again fell very rapidly and the actual mean level in the Blue Nile at Roseires was only 10 centimetres from the forecasted value.

I TERRENI AGRARI DELLE COLONIE ITALIANE.

Per il Dott. Armando Maugini.

Dell'Istituto Agricolo Coloniale Italiano di Firenze.

Il materiale bibliografico oggi esistente non permetterebbe la compilazione di una monografia completa sui terreni agrari delle colonie italiane; nè d'altra parte ciò potrebbe convenirsi ad una breve comunicazione che tende a riunire in poche pagine alcune fra le principali nostre conoscenze sull'argomento.

Per ragioni di spazio ho dovuto transcurare qualsiasi accenno alla costituzione geologica delle singole colonie quantunque sia convinto non si possa parlare di terreni agrari senza conoscere la geologia della regione.

Inizio l'esposizione della materia con lo studio dei terreni agrari dell'Eritrea per occuparmi successivamente di quelli della Somalia, della Tripolitania e Cirenaica.

Terreni agrari dell'Eritrea.

Primo ad occuparsi dei terreni agrari eritrei fu il Prof. Fausto Sestini che analizzò alcuni campioni prelevati dal Barone Franchetti nelle aziende di Gura e Godofelassi, illustrandone poi i resultati in una pregiata relazione [1]. Ma la più completa serie di analisi è quella riferita dal Dott. Gino Bartolommei Gioli nella sua relazione sull'agricoltura Eritrea [2].

Tutte le zone di maggiore interesse agricolo sono state studiate e l'esposizione dei risultati delle indagini chimiche sui terreni è riccamente corredata da osservazioni fatte con molto zelo dall'autore durante il suo soggiorno in colonia. Interessante e di utilissima consultazione è pure lo studio del Dott. P. Principi [3] su alcuni campioni di terreni eritrei prelevati dal compianto Prof. Ezio Marchi in occasione di una missione zootecnica nella colonia; ragguagli generali si trovano poi in numerosi altri lavori [4] riferentisi all'Eritrea.

Sull'altipiano eritreo sono molto comuni terreni di formazione autoctona, mentre nelle pianure occidentali e nella zona costiera prevalgono di gran lunga formazioni alluvionali dovute al trasporto di materiali terrosi per mezzo dei numerosi fiumi e torrenti.[1]

Sull'altipiano sono rappresentati tipi diversissimi di terreno sia per struttura fisico-chimica, che per profondità, proprietà fisiche e composizione chimica. I terreni dell'altipiano dell'Asmara, accuratamente studiati, sono nelle zone più depresse molto compatti per soverchio tenore di argilla, mentre nelle giaciture più elevate sono frequenti dei tipi sciolti, ricchi di scheletro. Molto varia la profondità; la roccia nuda che affiore è circondata da terreni superficialissimi, molto frequente invece una profondità da 1 a 3, fino a 6 metri. In genere la permeabilità è notevole, variabilissimo il colore. Chimicamente debbono considerarsi di media ricchezza; spesso ricchissime di ossido di potassio, l'anidride fosforica, in dose varia in relazione alla diffusione dei basalti (apatite), sempre deficente l'ossido di calcio, normale il contenuto di azoto.

Queste osservazioni pare possono estendersi ad una buona parte dell'altipiano eritreo.[2]

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[1] La composizione di questi terreni di alluvione deve essere notevolmente complessa e meriterebbe un'accurata indagine; infatti è noto che la degradazione delle rocce, causa precipua della formazio del terreno agrario, si compie in modo vario sotto l'influenza dei diversi climi. In Eritrea dalle zone temperate si giunge alle torride attraverso una lunga serie di forme intermedie. Ne consegue che il disfacimento delle rocce avviene diversamente nelle varie regioni della Colonia (di degradazione lateritica parlano fugacemente i Proff. Marinelli e Dainelli nel loro volume sull'Eritrea) e che questi vari prodotti di alterazione trascinati dalle acque partecipano tutti, in misura più o meno importante, alla formazione dei terreni alluvionali dei bassipiani.

[2] Un'osservazione degna di nota potei fare studiando un terreno molto compatto, nerissimo dell'altipiano Eritreo. Da apposite ricerche risultò essere la colorazione prodotta da uno strato di materia organica pochissimo alterata per mancata nitrificazione; ostacolo a questo processo biologico deve essere stato la difettosa circolazione dell'aria e dell'acqua e la deficienza di carbonato di calcio nel terreno. Terre in condizioni simili non debbono essere rare sull'altipiano Eritreo.

Ottimi e notevolmente argillosi molti terreni si Gura e Godofelassi, fertili ed importanti i territori pianeggianti del Seraè, della piana di Hazamò, di quella di Derentani. La conca di Cheren ha tipi diversi di terreno soprattutto in riguardo alla profondità, ma possiede una buona superficie coltivabile a suolo molto profondo.

Nelle pianure occidentali i terreni sono spesso di una fertilità meravigliosa; lungo il Gasc la vegetazione è rigogliosissima e sono comuni terreni simili a quelli fortunati del delta niliaco. Molto ricche risultarono le analisi campioni prelevati lungo il Barca.

Dal lungo e accurato esame dei risultati analitici si possono formulare le seguenti conclusioni a cui accenna il Dott. Gioli:

1° In generale in Eritrea prevalgono terreni sciolti, pure essendo frequenti le zone a terreno molto argilloso.

2° È costante la deficenza di carbonato di calcio che trova spiegazione nella modesta diffusione di rocce calcaree in colonia, se si fa eccezione per i calcari coralligeni delle regioni costiere.

3° Varia è la quantità di sostanza organica essendo questa in stretto rapporto con l'abbondanza di vegetazione; così nelle pendici orientali dell'altipiano protette da ricchi manti di boschi, si ha un contenuto più elevato che sull'altipiano.

4° Vicende analoghe di quelle della sostanza organica subisce l'azoto.

5° Sempre notevole il contenuto di ossido di potassio quantunque in forma poco assimilabile dalle piante; lo stesso dicasi dell'anidride fosforica che è però più modestamente contenuta nelle terre eritree.

Nel lavoro del Dott. Principi [3] che riguarda in modo speciale l'altipiano, è contenuta un'accuratissima indagine lito-mineralogica e sono messi in evidenza con molta chiarezza i rapporti fra roccia e terreno. "Le terre più importanti dal punto di vista agricolo sono quelle che derivani dal disfacimento di Basalti."

In questi ultimi anni l'attenzione del Governo della Colonia si portò sulla messa in valore del Sahel cioè della zona costiera a nord di Massaua. Nel bacino del torrente Falcat, nelle vicinanze della foce, sono già iniziati importanti lavori di sistemazione idraulica che consentiranno l'irrigazione di una vasta superficie. I terreni della zona in bonifica da me studiati, sono di buona struttura fisico-meccanica in relazione alla loro natura alluvionale, spesso molto profondi, poveri di carbonato di calcio, ma ben forniti di sostanze organiche, di anidride fosforica e specialmente di ossido di potassio.

Difetto di questi terreni che nelle condizioni attuali non si presenta molto grave, è l'eccessivo contenuto di sali solubili, prevalemtemente cloruro di sodio; oggi la salsedine, molto variabile nei diversi punti della zona in bonifica e quasi sempre in piccola quantità, ma non si può a priori escludere possa aumentare e rendersi dannosissima per effetto dell'irrigazione.

È probabile che una gran parte del Sahel Eritreo sia costituito da terreni simili a quelli del bacino del Falcat cioè più o meno salati, molto sabbiosi ne le immediate vicinanze della costa, argillosi nelle zone più interne di origine alluvionale, quasi sempre in buone condizioni di coltivabilità.

Terreni agrari della Somalia.

Dell'immenso territorio che costituisce la Somalia Italiana la parte compresa fra il Giuba e l'Uebi Scebeli si presenta in condizioni privilegiate per lo sfruttamento agricolo, cosicchè le poche nostre conoscenze sui terreni agrari si riferiscono a questa zona.

Si occuparono successivamente di questo argomento i Dottori Macaluso [5], Rossi [6], Fanelli [7], Mangano [8], Principi [10], Onor [11].

La prima persona tecnica che attraversò la Somalia Italiana Meridionale a scopo di studio fu il Dott. Cesare Macaluso; nella breve relazione di viaggio [5] l'autore accenna ripetutamente alla grande fertilità dei terreni. Il territorio percorso, in base a diversi fattori, soprattutto ai caratteri morfologici, fu diviso nel seguente modo:

1° *Terreni lungo la costa.*—In massima sabbiosi su sottosuolo madreporico, limitati verso l'interno dalle dune.

2° *Terreni formanti le dune litoranee.*—Che corrono parallelamente alla costa; questa zona, secondo Macaluso, avrebbe una profondità media di 3 km. La maggior parte delle dune, e le più alte, sono stabili, di colore e consistenza varia, coperte di vegetazione rigogliosa ed abbondante. Le dune mobili costituite da incoerente sabbia silicea, sono invece coperte da scarsa e povera vegetazione, prevalentemente di salsole.

3° *Terreni situati fra le dune e la piana.*—Costeggiano le dune per una profondità da 1 a 3 km. e sono leggermente inclinati verso la piana. Nella loro formazione partecipano le sabbie delle dune e l'argilla della piana, il colore predominante è il giallo rossastro, la vegetazione spontanea è molto rigogliosa.

4° *Terreni costituenti la piana propriamente detta.*—Che sono i più importanti nei riguardi agricoli e occupano i due bacini alluvionali del Giuba e dell'Uebi Scebeli. La composizione è pressochè uniforme più o meno argillosi, di notevole profondità e vario colore, la vegetazione è dappertutto rigogliosissima.

Lo studio fisico-chimico e chimico dei numerosi campioni di terreno prelevati dal Dott. Macaluso fu curato dal Dott. W. Rossi [6] che raggruppò i campioni secondo i territori a cui si riferivano; Merca, Brava, e Giumbo.

Eminentemente sabbiosi risultarono i terreni della zona costiera e quelli delle dune, salvo rare eccezioni di banchi di argilla; sempre poveri di azoto e di sostanze organiche. I terreni alluvionali della piana sono invece spesso molto argillosi e in essi abbondano generalmente i materiali organici e l'azoto. Fra i principi fertilizzanti l'ossido di potassio è sempre abbondante, raggiungendo spesso dei valori eccezionali (17-19 per cento) e ciò in relazione alla costituzione geologica delle regioni da cui provengono il Giuba e l'Uebi Scebeli. Il calcare è ovunque abbondandemente diffuso e in quantità quasi sempre notevole l'anidride fosforica.

Anche il Dott. Fanelli [7] analizzando alcuni campioni di terreni agrari della Goscia ottenne dei risultati molto buoni.

Nella primavera del 1908 l'On.Barone Leopoldo Franchetti e il Dott. Guido Mangano ebbero occasione, percorrendo la Somalia, di raccogliere larga messe di notizie ed osservazioni sui terreni agrari. Lo studio chimico dei campioni prelevati durante il viaggio, curato dal Dott. Mazzaron, è ampiamente discusso in una nota dal Dott. Mangano [8], le cui conclusioni sono molto concordanti con quelle già riferite dei Dottori Macaluso e Rossi.

Più recentemente (1911) due intraprendenti giovani, i Dottori Scassellati e Mazzocchi, percorsero la Somalia Italiana Meridionale raccogliendo dati preziosi su tutto quanto ha relazione col problema della messa in valore della colonia. Nell'unico volume finora dato alle stempe [9] è contenuto un cenno sui terreni agrari, mentre la parte che specialmente a questi si riferisce è di prossima pubblicazione. Il Dott. Scassellati ci fa sapere che i Somali distinguono cosi i terreni:

Harra medou (terre nere), ricche di humus, fertilissime, sono le preferite dagli indigeni; rappresentano antichi depositi alluvionali del Giuba e dello Scebeli.

Harra gudud (terra rossa), meno provviste di humus perchè non beneficate da recenti alluvioni a causa della loro distanza dai fiumi; sufficentemente fertili.

Harra adda (terre bianche), poco fertili diffuse molto lungo la zona di dune litoranee.

Utilissima è la nota del Dott. Principi [10] dove sono esposte le lunghe ricerche di laboratorio (analisi lito-mineralogica e fisica e qualche osservazione chimica) sui campioni di terreni raccolti dai Dottori Scassellati e Mazzocchi. La Goscia è la regione a cui si riferiscono la maggior parte dei campioni ma anche i territori di Brava e Merca sono molto bene illustrati. Il Dott. Principi conclude facendo risaltare i due gruppi in cui possono dividersi i terreni della Somalia Italiana: "Terreni sabbiosi formanti le dune e altri rilievi che si svolgono lungo l'Oceano e alcuni lembi di depositi fluviatili; e terreni più o meno argillosi e compatti che costituiscono gran parte della pianura alluvionale che si estende ai due lati del Giuba e dell'Uebi Scebeli.

Il Dott. Romolo Onor, consulente per le opere agrarie nella Somalia Italiana Meridionale, tratta brevemente dei terreni aggrari nella sua relazione sull'agricoltura Benadiriana [11] e per primo accenna al problema dei terreni salini, che pare abbiano in colonia notevole diffusione.

Le conoscenze sulla nostra colonia dell'oceano Indiano si accresceranno notevolmente quanto prima, con la pubblicazione della relazione di viaggio della missione composta dai Proff. Stefanini, geologo, e Paoli, naturalista, che per incarico del Governo della Somalia percorse la colonia rimanendovi circa un anno.

Terreni agrari della Tripolitania.

Il primo lavoro di grande interesse sui terreni agrari della Tripolitania è quello del Prof. P. Vinassa de Regny (1903) [12]; in una escursione geologica nei dintorni di Tripoli e di Homs, l'autore ebbe modo di fare molte importanti osservazioni sui terreni delle oasi e del cosiddetto deserto a sud di Tripoli, dei quali terreni da 'anche un accurato studio litologico, chimico e fisico.

Seguono a questo lavoro due modesti contributi di G. Sesti (1904) [13] e di G. Laganà (1905) [14]; anche la ricchissima serie di osservazioni raccolte dalla missione Sanfilippo-Sforza sarà preziosa per lo studioso ed è da augurarsi venga presto pubblicata.

Fin dai primi mesi dell'occupazione militare il Prof. Menozzi potè occuparsi dei terreni sabbiosi della Tripolitania e in una breve nota [15] espone i resultati delle sue indagini.

Segue poi l'accuratissimo studio della Commissione agrologica inviata dal Ministero di Agricoltura, Industria e Commercio sulla zona di Tripoli (1912) [16] e una breve memoria del Dott. A. Maugini (1913) [17] sui terreni delle oasi fezzanesi e di alcuni Uidian della Libia predesertica.

Finalmente le ultime pubblicazioni sull'argomento ci sona date dalle relazioni di viaggio della Commissione di studiosi inviata dal Ministero delle Colonie (1913) [18] e dalla Missione Franchetti (1913) [19] che si recò in Libia per conto della Società Italiana per lo Studio della Libia di Firenze.

Questi due ultimi lavori ci consentono di dare notizie sufficentemente esatte sui terreni agrari di una grande estensione della Tripolitania Settentrionale; il primo si occupa della vastissima zona compresa fra l'altipiano e il mare, il secondo in modo particolare tratta l'agricoltura nel Gebèl.

Onde le brevi notizie che seguono rappresentano le conclusioni delle già ricordate commissioni di studiosi, per quel che riguarda il terreno agrario.

Dopo ampia esposizione dei risultati analitici e in base alle numerose osservazioni fatte dai componenti la missione durante il soggiorno in Tripolitania, la Commissione Governativa conclude: "In tutta la Tripolitania Settentrionale, dal confine della Sirte e quello Tunisino; dalla costa al Gebel e nel Gebel stesso, per molte migliaia di kmq. di superficie esiste un solo ed unico tipo di terreno agrario. Le sue caratteristiche essenziali sono: la profondità più o meno grande la rilevante omogeneità della sua struttura; la scarsa proporzione di elementi fini in genere ed in particolare si quelli finissimi od argilliformi; la preponderante proporzione di sabbia silicea; la proporzione variabilissima di calcare. Esso quindi può definirsi: un terreno a struttura granulare, con tendenza all'uniformità, a grana grossa, siliceo o siliceo-calcareo, profondo."

Per quanto riguarda i principi fertilizzanti i terreni in parola contengono pochissima materia organica ed azoto, sono mediocremente forniti di potassio e meno di anidride fosforica. Queste deficienze non appariscono gravi; per la legge del minimo "la produzione vegetale dipende dalla sostanza alimentare che la pianta assimila in minore proporzione" e in Tripolitania, paese essenzialmente arido, il minimo fattore è rappresentato dall'acqua.

La commissione ritiene essere il terreno agrario della Tripolitania favorevole all'economia dell'acqua; l'assorbimento e la percolazione negli strati profondi sarà facile e l'acqua potrà muoversi in tutti i sensi nel terreno. Oggetto di studio è la formazione, molto diffusa in tutti i paesi aridi, di crostoni calcarei più o meno spessi a diversa profondità nel terreno; l'effetto di queste formazioni sulla vegetazione è vario secondo la loro profondità e spessore. Il Prof. Ulpiani [20] applicando ad alcuni terreni della Tripolitania il metodo proposto da Van Bemmelen, non esita a definirli lateritici; in un limo di uadi il rapporto: $\frac{\text{molecule di silice}}{\text{molecula di allumina}}$ risultò $= 0{\cdot}84$, come nei terreni tipicamente lateritici—Gortani [21] invece raggruppa i terreni della Tripolitania e della Cirenaica fra le " terre rosse " tipiche.

Non è qui possibile citare tutte le preziose osservazioni contenute nella relazione della Commissione Governativa, dove ogni problema è opportunamente trattato con chiarezza e sobrietà. Due notevoli contributi del Prof. Pantanelli [18], pubblicati nel Vol. II fra gli studi complementari e illustrativi della relazione, si occupano della concentrazione del liquido circolante e della microflora nei terreni della Tripolitania Settentrionale.

La salinità desunta dalla determinazione della conduttività elettrolitica del liquido pedolitico, è varia nei terreni studiati; i terreni coltivati delle oasi forniscono estratti acquosi poco concentrati, le sabbie delle steppe un estratto molto diluito, i terreni delle *sebkhe* sono carichi di sali— In genere i terreni della Tripolitania " cedono all'acqua una notevole quantità di colloïdi."

L'attività microbica è molto scarsa nei terreni studiati, spesso ridotta a zero nelle sabbie delle dune e della steppa. Anche nelle oasi sono scarsamente rappresentate molte classi di microrganismi utili all'agricoltura quali i nitrificanti, i pecti novori e i solubilizzatori dei minerali nel suolo.

Dei terreni agrari del Gebel tripolitano si occuparono per primi i componenti della Missione Franchetti e in modo speciale l'agronomo della commissione Prof. O. Manetti. Nella formazione dei terreni dell'altipiano, oltre alle azioni ditrasporto eolico della polvere quarzosa del sud, assume importanza la retrogradazione della roccia locale. Cosicchè si hanno due tipi estremi di terreni: le sabbie di trasporto eolico quaternarie, e il detrito della roccia locale costituita per lo più da calcari marnose. Questi tipi difficilmente si incontrano, mentre nella maggior parte di terreni partecipano in misura maggiore o minore le forme estreme. Non si ha quindi nel Gebel uniformità di terreno osservata nelle formazioni alluvionali ed eoliche del bassopiano costiero.

" Il suolo del Gebel non è così uniformemente profondo come il terreno nella zona di Tripoli . . . , nondimeno si può affermare che il Gebel è fornito in generale di un suolo assai spesso. Le massime profondità si raggiungono più frequentemente nel Tarhuna, nella cui parte centrale la coperta quaternaria è pressochè continua, mentre nella zona periferica del Gebel (Tarhuna nord occidentale, Msellata e Garian) le discontinuità del quaternario e la roccia più spesso affiorante rendono la potenza del suolo più piccola e più limitato il suo spessore."

Il Prof. Manetti, in base alle osservazioni fatte sul posto e ai risultati analitici di un numero molto ingente di campioni di terreni, accetta la distinzione dei terreni agrari fatta dagli indigeni in base alle loro proprietà fisiche:

Ard Hamra (terra rossa) è il quaternario di origine eolica molto diffuso in tutto il Gebel e nella steppa sud-Tripolina. È caratterizzato dal predominio di materiale sabbioso-silicei, mancanza quasi completa di scheletro, vario contenuto in calcare. Il Prof. Manetti fa risaltare la grande somiglianza della terra Hamra del Gebel con quella della pianura sud Tripolina.

Ard hammari (terra rossastra) poco diffusa (ficheti estensivi del Garian, molti frutteti del Msellata e del Tarhuna), non è sempre possibile distinguerla dal tipo precedente, dal quale differisce per una maggiore cementazione calcarea ed una colorazione più chiara. Rappresenta la forma di transizione fra le terre più sciolte (Hamra) e le più compatte (tèn).

Ard Tèn costituisceno i terreni in posto, dovuti allo sfacelo della roccia locale. Molto calcarei e compatti, di colore meno rosso dei precedenti, spesso poco profondi. Comune nel Garian e nella Msellata, meno nel Tarhuna; quasi sempre misti a porzioni più o meno grandi di sabbia eolica. Nella terra tènlo scheletro è spesso abbondante, le sostanze argilliformi in quantità superiore che in tutti gli altri tipi di terreno è abbondantissima quasi sempre il calcare.

Col nome di tèn gli indigeni chiamano anche i terreni nelle vicinanze immediate delle poche rocce vulcaniche (fonoliti) esistenti.

Dall'accurato esame dei risultati analitici per quel che riguarda la composizione chimica, l'autore cosi conclude:

" 1° I terreni tutto del Gebel sono, dal punto di vista delle sostanze fertilizzanti, assai poveri.

2° I terreni a tipo *tèn* contengono una quantità di potassa sensibilmente superiore a tutti gli altri.

3° Scarsa essendo la materia organica, deficentissimo risulta il quantitativo di azoto, parte del quale è stato riscontrato nei terreni sotto la forma più assimilabile (nitrati).

4° L'anidride fosforica è contenuta sempre in quantità manchevolissima nelle terre tutte; occorrerà quindi somministrarla dappertutto quando si vogliano ottenere dei raccolti continui di una certa entità.

5° La calce è sempre presente nel terreno, generalmente sotto forma di carbonato; il fosfato di calcio è solo limitato al Gebel el Gharbi.

6° Nonostante le deboli riserve di fertilizzanti, i terreni del Gebel sembrano essere suscettibili si assai buone produzioni, quando non manchi l'umidità.

7° Lo scarso potere assorbente, specie dei terreni più sciolti, ci fa prevedere che negli strati più profondi del terreno le soluzioni acquose abbiano una maggiore concentrazione di sali nutritivi che nei nostri comuni terreni, più forti e tenaci.

8° La massina permeabilità che si riscontra in molti terreni del Gebel (specie in quelli di tipo Hamra) fa prevedere che riserve d'acqua di varia importanza si accumulino durante la stagione delle pioggie in corrispondenza del profondo sottosuolo e che risalgano lentamente durante l'estate a mantenere in uno stato di vita, meno intensa ma normale, le piantagioni legnose esistenti in coltura asciutta."

Oggetto di breve studio sono anche i terreni ritenuti incoltivabili nel Gebel Tripolitano.

Sulla Libia predesertica e desertica si possiedono ancora pochissimi dati.

Per gentile concessione dell'Ing. Sanfilippo, ho potuto analizzare una serie di campioni di terreni libici prelevati dalla missione durante la lunga permanenza in Tripolitania.

Dei campioni studiati [17] alcuni si riferisconoa terreni di oasi (O. di Murzuk, Goddua e Brak) altri a terreni di alcuni Uidian—Ho potuto notare che poveri di calcare e di materiali argilliformi sono i terreni delle oasi, mentre ne sono abbondantemente forniti quelli degli Uidian.

Dalle ricerche lito-minerologiche, fisicomeccaniche e chimiche, è risultata evidente la grande affinità fra i terreni delle oasi fezzanesi e quelli delle oasi costiere, ciò che starebbe in favore alla tesi della comune origine eolica di questi terreni situati a molte centinaia di km. di distanza.

Terreni agrari della Cirenaica.

I pochi dati positivi oggi esistenti sui terreni agrari della Cirenaica li dobbiamo soprattutto alla Commissione inglese nominata dalla Jewish Territorial Organisation (Ito) che percorse molto velocemente un tratto abbastanza esteso di territorio (400 km. fra Derna e Bengasi) in cerca di una regione ove impiantare una grande colonia israelita.

La commissione [22] distingue dal punto di vista agrario il territorio percorso, in tre tipi:

1° Terreno arabile.

2° Terreno atto alla pastorizia.

3° Terreno atto alla foresta.

L'agronomo e chimico della commissione, Dott. Trotter, ha creduto di potere indicare le seguenti discutibili cifre:

	Per cento
Roccia calcarea scoperta	6
Terreno coltivabile...	23
Terreno coltivato	16
Colline	30
Pianure	25

Il terreno agrario occupa talora superfici limitate, altre volte grandi ripiani; di questi, Trotter studiò quelli di Derna, Cirene, Messa, e Mergi che sono i principali nella zona percorsa dalla commissione. In tutta la Cirenaica fu notata una grande sproporzione fra i terreni coltivati e i coltivabili.

Dopo l'esposizione dei risultati delle indagini chimiche e fisico-meccaniche sui campioni di terreni agrari della Cirenaica il Dott. Trotter conclude: "The soils of the Cyrenaica belong to that class most prized by the agriculturist."

Dopo l'occupazione italiana il Dott. Carlo Manetti, durante la lunga residenza a Bengasi, potè raccogliere dati e campioni sui terreni agrari del territorio. L'hinterland Bengasino [23] può dividersi nelle seguenti 3 zone:

1° *La pianura litoranea* che si estende per 12-18 km. intorno a Bengasi, lievemente ondulata e che si eleva verso il Gebel-Dakhar. In questa zona sono da distinguersi: *I terreni sabbiosi* prevalenti lungo la costa per la profondità di un km. circa, e i *terreni argillosi rossi*, ricchi di principi fertilizzanti e di ottima costituzione fisico-meccanica, che si trovano in gran parte della pianura fino ai piedi del Gebel. La profondità di queste terre rosse è varia ma spesso molto rilevante. Tutta la zona litoranea è stepposa nell'estate, ricca di vegetazione durante la stagione delle pioggie; una piccolissima superficie è attualmente coltivata.

2° *La regione dell'altipiano* che incomincia con le terrazze elevantisi sulla pianura costiera fino a raggiungere il margine settentrionale che poi degrada verso il deserto. I migliori terreni si trovano in genere in fondo a Conche, le cui pareti calcaree sono nude di qualsiasi vegetazione. Nella zona di Bengasi abbondano gli affioramenti calcarei che rendono sterile una grande superficie di terreno. La terra rossa predomina sull'altipiano, ma verso sud comincia ad assumere una tinta giallognola fino ad arrivare nelle sabbie della zona desertica.

3° *Zona desertica.*—Al sud della precedente, poco interessante nei riguardi agricoli.

In poche parole, i terreni predominanti in Cirenaica appartengono alla categoria delle terre rosse; verso Tobruk questo tipo scompare e sono diffusissimi terreni di colorazione giallo-biancastra per la grande diffusione delle arenarie. Frequentemente nelle terre della Cirenaica è molto abbondante lo scheletro; già l'Hildebrandt [24] aveva notato che i terreni agrari della Cirenaica sono meno sciolti di quelli della Tripolitania come oggi risulta chiaramente dalle analisi. Le terre della Cirenaica sono tutte eminentemente ferrifere; variabile la quantità di carbonato, di materia organica e azoto, in genere non fanno difetto i principi fertilizzanti.

È da augurarsi che le migliorate condizioni politiche della Cirenaica, consentano presto uno studio completo e rigorosamente scientifico della regione.

Nelle pagine precedenti ho riassunto una buona parte del materiale bibliografico che può utilmente consultarsi da chi desideri conoscere le caratteristiche fondamentali dei terreni agrari delle colonie italiane di dominio diretto.

Fatte alcune doverose eccezioni, in genere gli studi a cui si è brevemente accennato risentono troppo della specializzazione scientifica degli autori; cosicchè mentre possediamo utili ed ottimi contributi riferentisi alla composizione chimica e lito-mineralogica di molti terreni, ci mancano assai spesso le osservazioni lunghe e pazienti compiute sui campi, nell'ambiente in cui il terreno deve esplicare la sua capacità produttiva.

Noi Italiani dovremmo sempre aver presente che il maggiore ostacolo alla messa in valore delle nostre colonie è la deficente quantità di acqua. Irrigazione e arido-coltura sono dunque per noi problemi di alto interesse; specialmente quest'ultimo che si presenta di possibile applicazione su immense superfici delle nostre aride colonie. La conoscenza del terreno, rispetto alla profondità, uniformità di struttura, permeabilità, capillarità, perdite per evaporazione, ecc., è fondamentale per l'applicazione dei metodi di arido-coltura ed ad essa dovremmo in modo speciale mirare, se veramente teniamo a rendere di utilità pratica gli studi relativi al terreno.

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COSTITUZIONE GEOLOGICA E REGIME IDROGRAFICO DELLA SOMALIA ITALIANA MERIDIONALE.

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LA parte della Somalia Italiana da noi visitata a presa in esame in questa breve comunicazione può grossolanamente rappresentarsi come una regione di forma romboidale, limitata a nord est dal medio corso dell'Uebi Scebeli, a sud ovest dal basso e medio corso del Giuba, a sud est dall'Oceano Indiano, a nord ovest finalmente dalla linea di confine, stabilita con la convenzione italo-etiopica del 1908.

Dal punto di vista geologico, possiamo distinguere in questo ampio territorio due regioni aventi caratteri assai diversi. La regione interna, costituente una specie di poco elevato altipiano, che scende lentamente dalle ultime propaggini del massiccio etiopico e muore nella pianura a una cinquantina di chilometri dalla riva destra del basso Scebeli, e la regione esterna, o alluvionale costiera che forma una striscia litoranea, larga un centinaio di chilometri, insinuandosi però assai più profondamente nell'interno, in corrispondenza delle due valli principali.

La regione interna è costituita in prevalenza di ıocce attribuibili al Mesozoico, addossate ad un massiccio cristallino. Questo si estende assai ampiamente, da Bur Meldac fino oltre il Dafet, in una zona diretta da nord est a sud ovest, e costituita da granititi e quarziti con rari affioramenti di rocce basiche e gneissiche. Le quarziti, e specialmente le granititi, affiorano quà e là a formare delle collinette nude, pittoresche, veri scogli isolati in mezzo alla pianura, analoghe a quelle che il Passarge ha studiato nell'Africa Orientale tedesca, denominandole *Inselbergen.* Le roccie cristalline e specialmente le granititi, che sono le più diffuse sono per solito nascoste da un ammanto di materiale sabbiosi-siliceo di disfacimento, che non sembra adatto a trasformarsi in un buon suolo vegetale, che si mantiene infatti dappertutto coperto da una vegetazione più o meno rigogliosa, ma sempre con spiccati caratteri xerofili.

Le formazioni sedimentari, di età mesozoica, si addossano attorno a questo massiccio cristallino, specialmente da ovest e nord ovest. Constano soprattutto di una potente pila di strati calcarei che hanno fornito in vari punti ricche faune fossili, attribuibili al Giurese. Alla base dei calcari nella parte settentrionale della colonia (dintorni di Lugh, Dolo ecc.) esiste anche una serie di arenarie variegate, con gessi, studiate già da De Angelis[1] su materiali raccolti dal compianto Sacchi, durante la seconda spedizione Bottego. I calcari si estendono largamente lungo il Giuba anche sulla riva destra del fiume, nella colonia inglese del Jubaland. La terra rossa di disfacimento dei calcari è solo di rado e localmente adibita a coltura dagli indigeni (zona marginale del Baidoa) e non sembra a priori, molto adatta.

Esistono nella regione interna ampie plaghe occupate da pianure alluvionali, in rapporto con corsi d'acqua secondari, oggi solo temporanei, e poco importanti: principalmente il Baidoa e il Dafet, centri importanti di agricoltura indigena. Tutta la costa del Benadir è orlata da una catena di colline sabbiose, di colore rossastro, larga in media una ventina di chilometri e che raggiunge da qualche decina ad oltre 100 metri di altezza, mantenendosi a poche centinaia di metri, di rado a qualche chilometro dal mare. La forma delle colline, l'esistenza fra le singole catene, di depressioni chiuse, il materiale dal quale esse sono costituite fanno ritenere che il nome di dune, dato loro generalmente, sia in realtà appropriato: sono però dune antiche, la cui sabbia è ormai alterata e quà e là cementata leggermente e fissata da una vegetazione di steppa (mimose, euforbie candelabre, ecc.) che tutte le ricuopre: solo quà e là si addossano a queste dune antiche dune recenti ancora mobili, nude

[1] De Angelis d'Ossat e Millosevich. Studio geologico sul materiale raccolto da M. Sacchi. Seconda spedizione Bottego. Roma, 1900.

e candide. La cementazione delle sabbie di duna è avvenuta e avviene tuttora lungo la riva del mare, per opera di sorgenti e fors'anche dell'acqua marina stessa: si originano cosi delle arenarie poco consistenti, spesso bucherellate, formanti in vari punti coste a picco o piccoli promotori sporgenti.

Arenarie e calcari di origine marina contenenti resti di organismi di tipo molto recente non si trovano che al livello stesso del mare e solo lungo la costa. Verso la foce del Giuba ho potuto constatare che esse s'internano per due o tre chilometri, mantenendosi però sempre ad un livello di pochissimi metri: cosi a Gobwen e alla base della collina di Giumbo si raccolgono in copia le ostriche.

Pare evidente che dopo la loro formazione nessun apprezzabile sollevamento siasi verificato in questa parte della costa africana. Si sa che più al nord (capo Guardafui) e più al sud (Mombasa) si osservano invece analoghe formazioni marine postplioceniche, più o meno sollevate.

Come è ben noto il Giuba si apre una via al mare tra la collina di Giumbo e quella di Turkey Hill, che fanno parte della catena delle dune. L'Uebi Scebeli invece, giunto a una quarantina di chilometri dalla costa, trova sbarrato il suo corso naturale dalle dune stesse, che ne deviano il corso verso SW. Il fiume scorre cosi per oltre 300 chilometri parallelamente alla costa, e sempre da esso separato per mezzo delle dune, divagando in mille meandri, dividendosi in mille rami, impoverendosi sempre più di acque, finchè ristagna e muore nelle paludi dei Balli, a poche decine di chilometri dalle rive del Giuba. Analogamente a destra di questo in territorio inglese, il fiume Uaso Nyiro forma pure una palude senza raggiungere il mare.

Cosi avviene che le alluvioni del Giuba e quelle dello Scebeli si riuniscono insieme a formare una larga zona a C che abbraccia a S, SE, ed E la regione sopra chiamata interna e la separa completamente dalla zona delle dune costiere.

Mentre queste per la loro costituzione sabbiosa sono invase dalla vegetazione di steppa e anche nei pressi dei grandi centri non vengono che eccezionalmente adibite a coltivazioni dagli indigeni, la grande zona alluvionale del Giuba e dello Scebeli apparisce invece per la sua positura pianeggiante, un po'riparata dai venti marini, per la natura argillosa del suolo, per la presenza dei fiumi, che possono somministrare in copia l'acqua necessaria all'irrigazione, straordinariamente adatta alle colture di ogni genere.

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Veniamo ora a dire brevemente delle risorse d'acqua della colonia, e prima di tutto del Giuba e dello Scebeli. Come è noto, la parte inferiore del loro corso è pensile; essi sono perciò quasi completamente indipendenti dalle piogge locali, e dipendenti principalmente dal regime pluviale della parte alta dei loro bacini: cosi il periodo delle loro piene (maggio-settembre) corrisponde in parte ad un periodo asciutto della Somalia.

La portata dei due fiumi è assai diversa. Pel Giuba, che è una massa d'acqua indubbiamente più considerevole, si può calcolare in base ad alcune misure eseguite dall'Ing. R. Fano[2] una portata media, in piena, di oltre 600 mc. al secondo; esso va però impoverendosi più a valle, sia per causa dell'evaporazione e delle filtrazioni, sia specialmente perchè in molti punti trascina e inonda le circostanti campagne. L'Uebi Scebeli ha portata minore, specialmente nella parte inferiore del suo corso, che si prolunga tanto in regioni, ove l'acqua diviene quasi stagnante e ogni sorgente di alimentazione manca. La sua portata in piena viene stimata dal Fano a 270 mc. al secondo.

I dati che saranno desunti dai numerosi idrometri, che già da qualche anno funzionano in parecchi punti forniranno presto, vogliamo sperare, più copiosi e più esatti ragguagli, necessari per trovare il mezzo di sfruttare nel miglior modo e più completamente che si potrà la massa d'acqua disponibile.

Prescindendo da questi due corsi d'acqua perenni, altre risorse idriche esistono nel territorio studiato; ma, più

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[2] FANO, R.: Del Regime delle Acque nelle nostre Colonie (Somalia italiana) Istituto Coloniale italiano. 2° Congresso degli Italiani all'Estero sez. viii. Roma, 1911.

che per l'agricoltura su larga scala, esse sono utili (almeno allo stato attuale delle cose) per la pastorizia. Le plaghe calcaree e cristalline della regione interna e le dune costiere (cioè tutte le parti della colonia disadatte alla coltura e coperte dalla caratteristica boscaglia, o vegetazione di steppa) sono popolate da cabile di pastori nomadi, continuamente in emigrazione dietro i loro copiosissimi greggi di cammelli, buoi, pecore e capre. Questi hanno le loro abbeverate ai fiumi e innumerosi pozzi e sorgenti.

Nella regione interna sono specialmente ricche di pozzi e di sorgenti le plaghe calcaree. Là dove la massa rocciosa non è incisa da reticolati vallivi, pare che l'acqua imbeva la massa stessa, naturalmente fessurata ed infranta. L'acqua di base (grundwasser) si trova spesso a non grande profondità, si che non è stato difficile agli indigeni raggiungerla con pozzi profondi pochi metri, aperti coll'aiuto del fuoco nella viva roccia, specialmente in zone alquanto depresse: anzi in qualche punto l'acqua affiora al livello del suolo e origina vere sorgenti. Da queste devono tenersi distinte, geneticamente, le sorgenti di Baidoa, che si aprono pure in alto, ma in corrispondenza di una incisione nel margine dell-altipiano calcareo, originando cosi una piccola cascata, che potrà venire utilizzata per forza motrice.

La plaga cristallina non ha pozzi importanti: tuttavia la copertura sabbiosa eluviale, permeabilissima, deve dar luogo al suo contatto col sottosuolo roccioso a un velo d'acqua più o meno ricco. Esso però non ha potuto essere aggredito dagli indigeni (salvo quà e là vicino alle colline isolate) sia a causa della sua profondità, sia per la difficoltà di sostenere le pareti dei pozzi in terreno sabbioso. Tutti i piccoli pozzi che gli indigeni scavano in questa formazione trovansi costantemente insabbiati. In questa parte della colonia dei tentativi di pozzi tubulari avranno molta probabilità di successo.

Le alluvioni limitate, vallive, di questa regione interna hanno pure un livello acquifero, raggiunto dagli indigeni con pozzi profondi 5, 7 e fino 9 e 10 metri.

Importanti assai sono i cosi detti pozzi dei Galgial, che si trovano distribuiti nel territorio occupato dalla

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cabila di questo nome, formando una doppia linea parallela al corso del medio Uebi Scebeli, a qualche decina di chilometri sulla destra di questo fiume. Essi sono spesso circondati (come avviene di altri pozzi in colonia) da una formazione calcarea, travertinosa, ma il sottosuolo della regione pare sia sabbioso.

La zona della duna costiera ha una falda d'acqua sotterranea quasi continua, che trae origine dalla catena sabbiosa, permeabile e scende con deflusso continuo al mare. Ad essa si deve probabilmente la cementazione locale delle sabbie litorali. Essa alimenta una lunga serie di pozzi e sorgenti, che si estende senza interruzione lungo il mare, talora sotto al livello stesso dell'alta marea, dalla foce del Giuba fino a Itala ed oltre; e che malgrado la qualità non di rado salmastra dell'acqua, serve molto bene agli usi dei nomadi, vaganti sulla duna e all'abbeverata dei loro bestiami; non meno che all'uso degli indigeni nei principali centri abitati.

Anche qui, come pure all'interno della catena delle dune, sulla sinistra dello Scebeli a monte di Afgoi, dove pare esistono delle intercalazioni di sabbie eoliche nell'alluvione dello Scebeli, i pozzi tubulari potranno rendere non pochi servigi.

NOTE SUR LA FERTILITE NATURELLE DES TERRES DE LA VALLEE DU MOYEN-NIGER.

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Les terres de la vallée du Moyen-Niger doivent leur fertilité, non pas tant à leur composition chimique, c'est à dire à leur richesse en éléments fertilisants, qu'aux conditions extérieures favorables qui leur sont faites (lois naturelles; circonstances économiques; méthodes culturales consacrées par l'expérience).

D'une façon générale, on peut dire d'après les analyses déjà faites, que ces terres sont d'une richesse comparable aux bonnes terres à blé de France, au point de vue azote et potasse; mais elles sont beaucoup plus pauvres en ce qui concerne l'acide phosphorique et la chaux.

Néanmoins, les terres de la vallée du Moyen-Niger sont des terres fertiles.

Partout en effet, où l'alimentation en eau leur est assurée (pluies, eaux d'inondation; irrigation) elles sont réellement productives.

Cette fertilité naturelle est d'ailleurs parfaitement explicable: Elle résulte en effet, comme nous allons essayer de le montrer, d'une part (terres non inondées) d'un choix heureux des cultures, et d'une méthode culturale bien comprise; d'autre part (terres inondées et terres irriguées) de l'enrichissement périodique des terres en éléments fertilisants, dans des conditions un peu spéciales: enrichissement en azote aux dépens de l'air (microbes fixateurs d'azote); enrichissement en azote, acide phosphorique, potasse, chaux et humus, grâce aux substances fertilisantes diverses, charriées par les eaux d'inondation (fumier des troupeaux, ordures des villages, etc.).

I.—Terres non inondées.

(*a*) *Choix heureux des cultures; (petit mil, arachides et niébés).*

La culture fondamentale des terres non inondées est celle du petit mil. C'est là une céréale qui est au gros mil ce que le seigle est au blé; elle a pour dominante ou aliment préféré l'azote, et elle est peu exigeante, vis à vis des matières minérales.

Cette culture est en outre d'autant moins épuisante que les substances inorganiques puisées par le petit mil dans le sol reviennent à celui-ci, en presque totalité, soit directement, du fait de l'incinération ou de la décomposition naturelle sur place des tiges et des feuilles, soit indirectement, après digestion de ces éléments par les termites, ou du fait des troupeaux qui viennent consommer ces résidus, riches en principes nutritifs, et fument alors les lougans sur lesquels ils stationnent.

On s'explique donc fort bien qu'on puisse obtenir de bonnes récoltes successives, malgré que les terres soient un peu pauvres en acide phosphorique, en chaux, voire même en potasse, attendu que ces principes se trouvent régulièrement régénérés et remis en circulation tous les ans.

Cette considération, de l'abandon sur place des tiges de mil, après récolte des épis (pratique intérressante pour l'élevage) explique en même temps que le sol présente toujours une certaine richesse en humus et en azote.

Ce dernier élément, qui se trouve abondamment répandu dans l'atmosphère, est d'ailleurs comme on sait, dans certaines conditions, fixé dans le sol par certains microbes spécifiques, et peut finalement après transformations ultérieures, être utilisé avec avantage par les plantes cultivées.

Les conditions essentielles de cette fixation directe d'azote atmosphérique sont celles-là même qui sont nécessaires à la vie des microorganismes qui la réalisent; c'est à dire, d'une part, la présence dans le sol d'une certaine quantité de matière hydrocarbonée, telle que l'humus (aliment des bactéries fixatrices), et d'autre part une humidité convenable (condition également sine quâ non du développement de tout être vivant).

Ainsi, on comprend, aux Colonies aussi bien et plus qu'en Europe, l'importance dans le sol d'une certaine quantité d'humus et d'une certaine quantité d'eau, et par suite le gros intérêt tant du fumier que de l'irrigation.

En dehors du petit mil, les indigènes cultivent sur les terres hautes (terres non inondées) des arachides, des pois chiches et des niébés, toutes plantes améliorantes (légumineuses). Parfois, autour des villages sur terres régulièrement fumées un peu de gros mil et de maïs, ainsi que du coton.

(b) Méthode culturale bien comprise: culture sur buttes (dry-farming); labour profond, jachère et assolement.

D'une façon assez générale au Soudan et en particulier dans la région du Moyen-Niger, le petit mil est cultivé sur buttes, et il en est souvent de même pour l'arachide et le pois chiche.

Cette méthode culturale s'explique, en premier lieu, par suite de la nature particulière du sol.

Les terres à mil, qui nous occupent, présentent en effet des propriétés physiques un peu spéciales. Ce sont des terres limoneuses, c'est à dire à éléments extrêmement fins. Elles sont poreuses; la capillarité s'y exerce à merveille; mais elles se tassent rapidement, sous l'action de pluies un peu violentes (terres battantes), de sorte que, si l'on n'y prenait garde, le ruissellement y serait intense.

De là le grand intérêt et la véritable raison d'être de la culture sur buttes.

Autant de buttes en effet, autant de petites cuvettes intercalaires, qui vont donner autant de petites mares, chaque fois qu'un orage survient.

L'eau de ces lacs, en miniature, ne tarde pas ensuite à disparaître: Une partie est absorbée par la terre formant cuvette et s'en va former réserve dans le sous-sol, tandis que le surplus va alimenter la butte dans laquelle il remonte comme dans du sucre. Ainsi, l'eau de pluie est utilisée au maximum, attendu que le ruissellement est nul, et que la perte par évaporation est peu importante, grâce au binage soigné, que les indigènes pratiquent dans leurs lougans, aussitôt après la pluie.

Si l'on songe, maintenant que la butte mesure couramment 25 cms., 30 cms. et plus de hauteur (pour 45 cms. de diamètre à la base, et 45 cms. environ d'entre-buttes) on voit que cette méthode culturale correspond d'un autre côté à un véritable labour profond, et il faut reconnaître que malgré la rusticité de l'outil employé (daba = houe) les indigènes en maints endroits préparent leurs terres admirablement, et mettent à la disposition des plantes cultivées un sol à la fois bien aéré et bien ameubli.

En outre, la richesse du sol en humus est entretenue régulièrement par l'enfouissage des mauvaises herbes spontanées, que l'indigène ramène précieusement sur les buttes.

Cette pratique culturale comporte donc, comme on le voit, le sarclage, tout en présentant en partie les avantages de la jachère sauvage (engrais vert).

Enfin, si on y prête attention, on reconnait que la manière de faire des indigènes, en dehors de l'intérêt qu'elle présente parfois sous le rapport du drainage, comme aussi au point de vue du tallage, ou encore de la défense des lougans (en évitant un entraînement rapide de la terre fine par les eaux ou par le vent) comporte, somme toute, une sorte d'assolement; attendu que, soit d'une année à l'autre, soit de deux ans en deux ans, les buttes se déplacent dans le champ.

La butte nouvelle vient prendre la place de l'entre-butte au centre du carré formé par les anciennes buttes, qui participent chacune, pour un quart, dans la formation de la nouvelle butte. Tout se passe finalement comme si on cultivait d'abord une moitié du champ, puis ensuite l'autre.

Ainsi, la culture sur buttes, telle que la comprennent les indigènes, est une méthode culturale parfaitement rationnelle. Cela ne veut point dire qu'elle est absolument idéale. Il faut toutefois en reconnaître le bien fondé, et on devra en conserver l'essence, si on cherche à la modifier dans le but par example d'augmenter les rendements ou de diminuer la main d'œuvre. Celle-ci est en effet considérable; mais pour le moment elle est bon marché, et n'intervient pas dans le calcul du prix de revient de la récolte.

II.—Terres inondées.

(*a*) *Enrichissement direct par les microbes fixateurs d'azote.*

Si les terres non inondées s'enrichissent en azote, aux dépens de l'atmosphère, il en est de même à plus forte raison des terres inondées, attendu que d'une part la nature physique de ces terres (terres argileuses) et d'autre part les conditions extérieures (humidité, végétation) sont très favorables.

(*b*) *Fumier des Troupeaux.*

Quand on parcourt la zône d'inondation des cercles de Djenné ou de Mopti, au cours de la saison sèche, c'est à dire, après le retrait des eaux du Niger, on est frappé par le nombre considérable de têtes de bétail qui vit alors sur les pâturages naturels bordant le fleuve ou les marigots qui en dépendent.

Tout le pays, à allure de plaine, apparaît alors comme une vaste prairie remplie de beaux troupeaux.

Il ressort des derniers recensements (1910-1913) pour la population bovine (mâles et femelles) du delta central nigérien les chiffres suivants:

Cercle de Djenné	72,990 têtes
,, ,, Mopti...	41,000 ,,
,, ,, Niafunké	84,930 ,,
,, ,, Goundam	350,000 ,,
,, ,, Tombouctou	19,850 ,,
Au total	568,770 têtes

soit plus d'un demi-million de têtes de gros bétail.

Si on fait le calcul du poids de fumier (matières solides à l'état sec) produit par ce bétail, alors qu'il vit sur les pâturages de saison sèche (terres inondées), c'est à dire, pendant neuf mois sur douze, on arrive, d'après les données généralement admises, au résultat suivant: 189,000,000 kgs.

C'est, comme on voit, une source intéressante d'éléments fertilisants.

Elle intervient à coup sûr pour une bonne part dans le maintien de la fertilité des terres cultivées, faisant partie de la zône d'inondation.

Au moment de la crue, en effet, les eaux débordantes du fleuve balaient les pâturages situées de part et d'autre; elles charrient ainsi jusqu'à la limite des terres inondées tout le fumier qu'elles trouvent sur leur passage.

Le fumier, une fois détrempé, se désagrège, se délite, et l'eau qui le transporte devient ainsi une véritable eau d'égoût, c'est à dire un élément fertilisant de premier ordre, pour les rizières, les terres à gros mil et les terres à blé (terres irriguées).

(*c*) *Gadones ou Fumier des Villages.*

L'eau du fleuve s'enrichit également en éléments fertilisants, au niveau des nombreux villages, installés sur la berge même du Niger, lesquels villages lui abandonnent toute l'année durant, mais principalement au moment des hautes eaux, tous les déchets de leur industrie ou de leur alimentation (têtes et arêtes de poissons, balles du mil); les ordures ménagères (balayures des cases) ou le fumier des animaux vivant en stabulation au village: chèvres, moutons, chevaux et bourricots.

Il convient enfin de citer, comme jouant un rôle incontestable dans la fertilisation naturelle des terres inondées, les feuilles d'arbres, et les débris végétaux herbacés divers, qui contribuent puissamment, soit sur place, soit après transport, à la formation de l'humus, au moment de leur décomposition.

Telles sont, exposés très succinctement, les principales remarques qu'il m'a été donné de faire, en ce qui concerne la fertilité naturelle, au cours d'une étude sur place des terres de la vallée du Moyen-Niger.

Les conclusions qui en ressortent sont les suivantes:

1° Les méthodes culturales indigènes, pour empiriques qu'elles sont, ont en général un bien-fondé et une raison d'être. Leur étude est donc instructive, et peut fort bien être profitable à la colonisation européenne elle-même.

2° La vallée du Moyen-Niger ne manque pas d'être intéressante. C'est un pays essentiellement agricole, et si les terres y sont généralement un peu pauvres par elles-mêmes, elles n'en sont pas moins fertiles et productives, grâce à un ensemble de circonstances naturelles ou économiques particulièrement favorables.

En particulier, le bétail qui est le point de départ et la base de la richesse du Soudan, nous apparaît ici comme l'agent par excellence de la fertilisation périodique des terres.

C'est donc, dans l'union étroite de l'élevage et de la culture, comme aussi dans le développement des entreprises d'irrigation, qu'est le secret de la mise en valeur de ce pays.

MALAYAN RUBBER AND COCONUT SOILS.

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For the past eighteen months the writer has been engaged solely in the examination of the soils supporting rubber, coconuts and rice in the Federated Malay States. Estates have been visited in nearly every district in the country, and an endeavour has been made to obtain an insight into the relationship between the soil's productiveness and its mechanical and chemical composition.

The subject is one of great importance to agricultural interests: the land has no previous cultivation history, and has for the most part been claimed from the original jungle only within the last few years. The selections made during the "boom" may be likened to a lottery which is only now beginning to reveal its prizes—and its blanks; for, in many instances, it is apparent that the yields likely to be obtained will fall far short of the anticipated.

The best rubber land is at least twice as good as the average indifferent, and in the case of coconuts three times or more as good; from which figures some idea may be gathered of what significance to the investor the choice of land is.

There is, however, no doubt that many of the less suitable soils, both rubber and coconut, are open to vast improvement under proper treatment; but it is essential that this should be started whilst the plantation is young, so that an early recognition of the facts is essential.

In the present paper is given an account of the conclusions the writer has reached on the points mentioned above, and a few observations on the selection of land. Finality is not claimed, as new points of view are continually presenting themselves; but it is hoped that these notes will serve for comparison with those forthcoming from other tropical countries in which perhaps knowledge of the subject is in a state more advanced.[1]

It has not been possible as yet to undertake any bacteriological work, but it is hoped to do so later, as the solution of many problems of interest may be expected from this mode of attack.

To prevent confusion, it will be convenient to keep separate the remarks on the composition of the rubber and coconut soils respectively, but as regards the methods of improvement that may be employed, these are of a general nature and apply equally to both; they, therefore, will be dealt with at the end.

Rubber Soils.

Mechanical Composition.—The soils on which rubber is planted in the Federated Malay States may be divided into three classes: those composing the undulating land, rising up to 500 ft., that broadens down from the central range of granitic mountains; the flat land forming the plains and valleys and formed alluvially from the former; and the flat, peaty, coast soils, probably fairly recently laid down by the sea, and, at the time of reclamation, consisting of tidal mangrove swamp.

Of these the first and the last have produced the highest yielding estates: the first because, owing to the light sandy nature and perfect natural drainage, deep and extensive rooting has been possible; the last when artificially well drained only, and when sufficient organic matter is present to have the same effect as sand in rendering the soil light and porous. Where both these conditions are not fulfilled the land is far from being satisfactory and is in some cases proving a source of great anxiety to the planter.

The second class mentioned, the inland alluvial soils, is less suitable, not on account of any deficiency in plant food material, but because of its close and impermeable texture. It contains little organic matter, and large pro-

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[1] The methods of analysis adopted are those recommended by Hall and Russell.

portions of the silts and clay. Consequently, even when adequately drained, root growth is restricted and is mainly confined to the surface. Such soils crack badly in dry weather and the trees suffer severely.

These observations must be regarded as being general only; hill soils of a clayey type are to be met with, whilst, on the other hand, some low-lying soils are sandy in texture. In the following table are given the percentage results of mechanical analyses of representative samples of the sandier soils, all of which are excellent yielders:—

	1	2	3	4	5
Coarse sand	Nil	Nil	Nil	Nil	Nil
Fine sand	61·4	56·0	60·1	53·0	40·8
Silt	9·2	12·1	8·1	9·3	6·0
Fine silt	9·4	4·2	8·8	13·6	16·1
Clay	17·7	25·9	19·5	22·0	24·6
Humus	2·3	1·8	3·5	2·1	2·5

No. 1 is from the Government Experimental Plantation at Kuala Lumpur, where trees 12 to 14 years old, numbering now about 90 to the acre, are yielding at the rate of about 9 lb. per tree per annum. The remainder are all from well-known estates.

No. 2, on which the trees are 11 years old, gives 600 lb. per acre. Nos. 3 and 4, both 9 to 10 year trees, 500 lb. approximately; and No. 5, where the age is 8 years only, 450 lb.

It is seen that the proportion of sand to fine silt and clay ranges from 2:1 and over in the first three to 1:1 in the case of No. 5.

The sandiest soil under rubber the writer has had as yet occasion to examine contained no more than 71 per cent. of sand to 11·4 per cent. of clay and 6·9 per cent. of fine silt. The yield was poor, but the chemical composition was poor too, and it would not be safe to regard this degree of sandiness as being one necessarily to be associated with diminished returns. No statement regarding the limit can therefore be made.

The texture of typical alluvial clay soils, class No. II, is shown by the following percentage figures. On land of this type 8 year old trees are usually found to yield not more than about 250 lb. per acre, or 2 lb. per tree.

	6	7	8	9	10
Coarse sand	Nil	Nil	Nil	Nil	Nil
Fine sand	19·3	13·3	2·4	21·2	3·5
Silt	10·4	28·7	13·5	44·5	19·9
Fine silt	21·7	21·5	31·0	16·8	33·8
Clay	46·6	34·5	50·4	16·0	38·8
Humus	2·0	2·0	2·7	1·5	4·0

No. 9 is an instance in which the closeness of texture is due to the large preponderance of silt, the growth here being exceptionally poor. In the other cases the predominance of the clay and fine silt fractions is such as in Europe would probably be associated with extreme infertility.

Stones and gravel are very rarely found in Malayan soils; in fact, in most cases no material coarser than 0·5 mm. is met with.

Chemical Composition.—It seems characteristic of tropical soils that the analytical results yielded by even the most fertile of them, are much poorer than those of temperate climates.

This is particularly noticeable when comparing the "available" amounts of potash and phosphate; but no doubt the higher temperature and greater rainfall cause more rapid decomposition of the complex soil constituents, and also perhaps produce conditions more favourable for bacterial growth, so that the plant has always a sufficiency to draw upon.

Nitrogen.—The percentages of nitrogen in the ten soils whose mechanical analyses have been given are as follows:—

No.	Percentage	No.	Percentage
1	0·091	6	0·20
2	0·090	7	0·19
3	0·177	8	0·248
4	0·114	9	0·078
5	0·127	10	0·20

Nos. 1 and 2 being the best yielders, it is seen how little nitrogen the rubber tree requires; in fact, manurial experiments on No. 1 have shown further addition of this element to have only a very slight effect, small though the quantity present is.

As analyses have indicated that in producing a crop of 400 lb. of dry rubber only 3½ lb. of nitrogen are taken away, it is not to be expected that very general recourse to nitrogenous manuring will be necessary. Probably in the near future such treatment will only be required on hillsides damaged by wash and on old tapioca land and possibly coffee land.

In no case has any relationship been traced between yield and nitrogen content.

Potash.—The same ten soils may be retained as examples throughout; the following table shows the percentage amounts of potash they contain:—

No.	Total	"Available"	No.	Total	"Available"
1	0·118	0·0057	6	1·30	0·0073
2	0·142	—	7	0·376	0·009
3	0·250	0·0084	8	0·65	0·0096
4	0·139	0·0052	9	0·36	0·0086
5	0·212	0·0092	10	0·459	0·0081

The quantities present in the clay soils are, as was to be expected, greater. The lowest figure yet obtained for "available" potash is 0·004 per cent., and this was from a good yielding estate. No relationship between potash content and fertility has as yet been traced, and it seems likely that in most types of Malayan soil sufficient is always present for the ordinary needs of the tree. In the prevention of the effects of drought, however, artificial potash fertilizing is effective even on a soil containing as much as 0·015 per cent. "available"—a phenomenon observed in other countries and with other crops.

Phosphate.—With the exception of the peaty soils, which will be dealt with in connection with coconuts, the soils in Malaya are markedly deficient in this element. The percentage of this constituent in the soils whose other analytical characteristics have been given are as follows:—

No.	Total	"Available"	No.	Total	"Available"
1	0·023	0·0029	6	0·069	0·0013
2	0·059	—	7	0·035	0·0028
3	0·045	0·0020	8	0·051	0·0061
4	0·045	0·0022	9	0·0133	0·0020
5	0·029	0·0033	10	0·032	0·0029

Phosphate appears, in fact, to be the limiting factor, and in all cases where differences of fertility not ascribable to texture or drainage have been noticed, they have been directly referable to the phosphate content.

Comparing soil 5, for instance, with another from the same estate, of which the mechanical analysis is practically the same, which contains as much nitrogen and more potash, and yet gives only 300 lb. per acre in place of the former's 450 lb., from equally old trees, it is seen that the "available" phosphate present in the worse-yielding soil is only half that in the other (0·0017 to 0·0033 per cent.). A field poorer still from the same place contained only 0·0012 per cent. "available."

Still it is not possible to lay down any rule as to the minimum quantity essential for a satisfactory yield as this must depend on the texture. In two soils the amounts of available plant food required to produce an equal effect may be assumed to be inversely proportional to the extent of root development attained by the trees in those soils, other conditions being equal.

Lime.—The hill soils normally contained from 0·02 to 0·10 per cent. of lime, the clay soils from 0·15 to 0·30 per cent. In rare cases only, usually coast soils, is up to 1 per cent. found.

Small though these quantities seem, they yet appear to be sufficient, except in the case of acidic peaty lands.

It is by no means proved that liming is necessary on the lighter lands; in fact, on No. 1 it has been found to produce very little effect on the yield of the tree. On the clays, however, it is of benefit in improving the texture, and liming is the only measure capable of producing amelioration that has as yet been tried.

Coconut Soils.

Although native-owned coconuts are to be found in every part of the country, on all classes of soil, those owned by European companies are, with a few exceptions, to be found on the more or less peaty lands lying along the west coast. When well drained, this soil proves itself admirably adapted to the cultivation; sometimes the trees begin to fruit as early as 4 or 4½ years, and by their eighth or ninth year are yielding yearly sixty to eighty nuts per tree.

These lands are characterized by being very clayey but containing a considerable quantity of organic matter, rendering them almost black in appearance. They are well supplied with nitrogen, and with potash and phosphate, both in the total and "available" forms.

Observations go to show that if badly drained they are infertile; but that for coconuts the drainage need be less deep and thorough than for rubber.

Instances can be pointed to in which coconuts and rubber are growing side by side, the former yielding magnificently, the latter hardly at all.

Inland the tree seems to prefer a soil of good open texture just as does Hevea, and on the heavy clays yields are poor, only twenty to thirty nuts per annum.

The writer has not yet had an opportunity of visiting or examining any of the east coast soils, on which the tree is reputed to give phenomenal yields when growing apparently in pure sand. Such very sandy soils as have come under notice have been associated with extremely low yields, unless heavily manured.

The following percentage analyses represent some of the best west coast soils:—

Mechanical Analyses.

	1	2	3	4	5	6
Coarse sand	Nil	Nil	Nil	Nil	Nil	Nil
Fine sand ...	10·9	9·5	7·7	6·1	20·2	12·1
Silt ...	25·2	25·4	20·9	22·7	20·8	18·2
Fine silt ...	35·1	35·5	33·1	39·2	30·9	33·9
Clay ...	21·4	20·8	30·2	22·8	22·7	32·4
Humus ...	7·4	8·8	8·1	9·2	5·4	3·4

Chemical Analyses.

	1	2	3	4	5	6
Loss on heating ...	16·4	19·4	13·1	16·0	15·9	10·9
Potash	0·334	0·224	0·555	0·290	0·407	0·345
Phosphate... ...	0·0885	0·098	0·076	0·081	0·064	0·043
Lime	0·20	0·20	0·24	0·13	0·13	0·10
Magnesia	0·35	0·25	0·40	0·39	0·16	0·25
Nitrogen	0·380	0·446	0·230	0·463	0·279	0·174
"Available" potash	0·0085	0·0420	0·0196	0·0150	0·0333	0·0347
"Available" phosphate	0·0223	0·0580	0·0430	0·0220	0·0160	0·0050

It is not possible to draw comparisons between these soils; as far as estimate is possible, owing to different ages of trees, etc., their yielding capacity is equal, and is the maximum attainable.

When differences of yield do exist they may be ascribed either to different cultivation policies or to variations in the degree of drainage.

It is not improbable that in all these soils the amounts of the various plant foods present are greater than the tree requires for the development of its maximum productivity.

More light on the relation of soils to yield can be obtained from a study of some inland soils, percentage analyses of which are given in the following tables:—

Mechanical Analyses.

SERIES I.—GOOD SOILS.

	1	2	3	4	5	6	7
Coarse sand ...	Nil	Nil	Nil	Nil	Nil	Nil	29·4
Fine sand ...	69·6	62·4	83·9	73·0	70·0	72·3	38·2
Silt	6·6	6·7	6·3	2·1	4·9	4·1	3·7
Fine silt ...	7·9	18·2	4·5	11·1	9·4	5·3	7·8
Clay... ...	13·9	11·1	3·8	12·2	14·0	15·3	19·3
Humus ...	2·0	1·6	1·5	1·6	1·7	2·0	1·6

SERIES II.—POOR SOILS.

	1	2	3	4	5	6
Coarse sand ...	Nil	Nil	Nil	7·7	26·3	20·7
Fine sand ...	83·8	91·0	87·8	59·6	36·1	28·1
Silt... ...	3·5	1·6	2·2	6·4	4·3	3·2
Fine silt ...	5·6	4·9	3·4	11·3	8·2	7·7
Clay ..	6·2	1·5	5·4	13·7	23·5	39·0
Humus ...	0·9	1·0	1·2	1·2	1·6	1·3

Except for No. 2 in Series II, all these soils are seen to be of good texture, and no distinction between the "good" and the "poor" can be drawn. No. 3 of the "good" list, for instance, contains less clay than Nos. 1 and 3 of the "poor," which might otherwise have had their infertility attributed to lack of this substance.

Recourse to chemical considerations must therefore be made to find an explanation for the differences.

The percentage results of chemical analyses are given in the next table:—

Chemical Analyses.

Series I.—Good Soils.

	1	2	3	4	5	6	7
Loss on heating	5·8	7·1	3·3	4·4	5·6	4·6	7·1
Potash ...	0·060	0·124	0·103	0·144	0·053	0·075	0·153
Phosphate ...	0·055	0·044	0·051	0·0316	0·0335	0·059	0·0476
Lime ...	0·10	1·2	0·09	0·04	0·08	0·04	0·02
Magnesia ...	0·04	0·03	0·02	0·05	0·06	0·05	0·03
Nitrogen ...	0·098	0·080	0·077	0·080	0·085	0·100	0·078
"Available" potash	0·0065	0·0191	0·0122	—	0·0097	0·0100	0·0084
"Available" phosphate	0·0114	0·0073	0·0085	0·0135	0·0110	0·0098	0·0029

Series II.—Bad Soils.

	1	2	3	4	5	6
Loss on heating ...	2·3	2·5	3·3	4·1	7·7	9·8
Potash	0·033	0·021	0·047	0·140	0·144	0·128
Phosphate	0·0087	0·0086	0·016	0·029	0·029	0·0356
Lime	0·02	0·05	0·17	0·018	0·02	0·02
Magnesia	0·10	0·05	0·20	0·02	0·02	0·02
Nitrogen	0·045	0·062	0·06	0·06	0·076	0·068
"Available" potash ...	0·0020	0·0043	0·0042	0·0500	0·0080	0·0073
"Available" phosphate	0·0017	0·0017	0·0011	0·0053	0·0016	0·0017

The first three soils of Series II are probably deficient in all the plant food constituents, nitrogen, potash, and phosphate. On No. 1 are old trees yielding only a few nuts a year. No. 4 is well supplied with phosphate and potash but lacking in nitrogen; it has yielded during the past three years an average of only twenty-four nuts per tree. The average for No. 5 for the same period is forty nuts; this soil contains very little available phosphate, as also does No. 6, the average for which is thirty nuts per tree.

The soils in Series I are all excellent yielders, the trees giving seventy to eighty nuts a year. No. 3, in fact, which is manured regularly with cow-dung, is stated to yield 100 nuts per tree. This soil is from a small native holding. None of these soils contains much nitrogen, the percentage being about the same as seemed sufficient in the case of rubber. Potash and phosphate are present in all in good amounts. Soil No. 7, however, in which the available quantity of the latter substance is less than in the others, has for several years been showing a constantly diminishing yield, which has dropped from eighty nuts to fifty.

Manuring coconut trees with salt is a very common practice amongst most Eastern races, and probably originated in the observation that trees planted by the sea so often do well. Although salt is not a necessity—many inland plantations to which it is never applied give high yields—it is undoubtedly in many cases beneficial. Probably its action is to increase the amount of "available" potash in the soil.

A much-disputed point amongst the coconut cultivators is whether to clean weed or to allow grass to grow. The writer's observations have led him to the conclusion that the latter practice is unsound; probably on account of the formation of toxins, as demonstrated at Woburn and other places. On the other hand, clean weeding has its disadvantages—the soil gets baked and loses its humus more quickly, and on slopes loss results from wash.

A better practice would be to grow a leguminous cover crop, to be fed to cattle or turned in at the commencement of the dry season. The coconut tree suffers severely in times of drought and a timely mulch may have an effect of great importance on the ensuing season's yield. A feature about a coconut plantation is that the growing of such a crop is at all times possible. With rubber, on the other hand, after about the fourth year the shade is too dense to permit of anything being interplanted.

Soil Amelioration.

In the case of both cultivations the least suitable soils, and the ones most difficult to deal with are the heavy clays that have been described.

Liming is one method of treatment for the purpose of flocculating the clay particles and thus lightening the soil, making it more porous. Lime, however, is very expensive in Malaya, costing nearly £2 per ton; for the above purpose a large quantity is required, and altogether it is doubtful whether the results would justify the expenditure.

The other method of improving such a soil is by green manuring. This must, however, be started early, when the trees are young, as only when light has free access to it can a cover crop be grown. No suitable plant that will grow in the shade has as yet been found. The seed should be sown at the commencement of the wet season, in September or October, and the crop dug in deeply about the following February. A second sowing might be possible in May, but one crop a year should be sufficient. Repeating this for three seasons, or as long as the shade is not too dense, will result in a large quantity of humus being incorporated with the soil, rendering it lighter and more pervious, beside increasing the nitrogen content.

A suggestion that seems well worth a trial is to dig narrow trenches 3 ft. deep between the trees, and to bury cow-dung or, as this is rarely obtainable, a green manure, preferably together with some basic slag, in them, finally lightly replacing the soil. These places, to which the young rootlets will rapidly be attracted, will serve as ventilating shafts, and should have a beneficial effect on the health of the tree.

Another serious question is that of the prevention of wash. It is no uncommon sight to see numerous deep furrows cut by the rain water running down the sides of hills planted with rubber, from which the surface soil is obviously being rapidly washed away. Here again a cover crop will prove of great value, but the best preventive undoubtedly is to terrace the land. The high cost is the argument used against this operation, but those who have carried it out hold the opinion that this will be adequately compensated for by the greater rate with which the coolies will be able to tap when the trees come into bearing.

Choice of Land.

In the course of travelling, the writer has made a few observations on the relationship of forest growth to the nature of the soil, which may here be recorded.

On deep soils of good texture—that is, containing a fair proportion of sand—the jungle trees have trunks round at the base, like the Hevea tree, and attaining 3 ft. to 4 ft. in diameter. On the other hand, where the soil is clayey and the trees shallow-rooted, the buttressed type predominates. A very stiff clay, such as is occasionally met with, may support trees only a few inches in diameter. Swampy lands along the coast usually grow species of mangrove, inland swamps mangrove also, *Pandanus* spp. and *Nipa fruticans.* Bamboo growth is an indication of good texture; but where the associated undergrowth is scanty and of a fibrous nature, such as small palms, the soil is probably too sandy to be fertile. Extreme infertility, either on sand or clay, is denoted by the presence of species of *Nepenthes,* the insectivorous "pitcher plant."

THE MANURING OF BANANAS.

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On looking through the publications on banana culture, one must notice the fact that the manuring of this crop receives but scant treatment, and very few results of manurial experiments are reported. In a recent paper on "Bananas and Their Utilization" [1], which undoubtedly is an up-to-date and most comprehensive treatise, the manuring of the crop gets a bare two pages out of a total of 120 pages. This is not to be wondered at, when we consider that hitherto in all banana-growing countries the culture of the plant was of a most reckless nature, a veritable "Raubbau" in the fullest sense of the word, as large areas of country under bananas were simply continually cropped, for years and years, without any attention to manuring, and abandoned when the crops, due to complete exhaustion of the soil, became unprofitable. New lands had then to be taken up, cleared and put under bananas. This state of affairs continued as long as land of easy access and near the seaboard was available.

It was fortunate that in the State of Queensland such abandoned lands were found to be eminently suitable for the growth of other crops, and more particularly sugar-cane, and thus the great waste of leaving large stretches of fertile country uncultivated was avoided. The banana industry itself, however, suffered, as from a yearly crop of about 4½ million bunches in 1898, it has dropped to an average yield of a little over 1 million bunches in the last few years. The cultivation, which was originally entirely in the hands of Chinamen, passed more and more into the hands of European farmers, and for this reason it was desirable to find means to utilize old banana lands again for banana culture.

The carrying out of manuring experiments in the northern tropical districts presents many difficulties, and one series of experiments established by the Department of Agriculture and Stock, under my direction, had to be abandoned; another series was started last year in the neighbourhood of the Kamerunga State Nursery, and this has already suffered from very adverse climatic conditions, viz., an unprecedented spell of dry weather last year, followed by exceptionally heavy rains this year.

Several manurial experiments carried out in Southern Queensland, under sub-tropical conditions, gave excellent results, and demonstrated, beyond doubt, that exhausted banana lands may, by thorough cultivation and the aid of heavy dressings of artificial fertilizers, produce crops equalling those obtained from virgin lands. Of course not all exhausted lands may give such good results, as it is of great importance that the soil be in good physical condition and, above all, contain a fair amount of humus.

As to the class of soil required for banana culture, authorities somewhat differ, but the contradictory statements one meets are perhaps more apparent than real, and are largely influenced by local conditions.

Like all tropical plants, bananas require an abundant and regular supply of moisture, and therefore the soil must possess a good water-holding capacity, but at the same time be well drained, to prevent the water becoming stagnant near the surface.

The manager of the Experimental Garden at Kwai (German East Africa) states [2]: Bananas like moist, swampy flats with a rich, fat soil. Soil rich in humus always yields larger crops of bananas than clayey soil. Against this statement, which undoubtedly is due to exceptional local conditions, we must note in Dr. Grotewold's paper on banana culture [3], that bananas love moisture, but do not thrive in swamps. The soil must also be free from excessive amounts of salt, and flats containing an excess of salt may be made fit for cultivation by flooding them with water for some time, as practised in Colombia.

With regard to humus, Henricksen [4] states, that while it is desirable, it is not absolutely essential, because most of the soils producing bananas in Jamaica contain but little humus. The typical banana soils of Annatto Bay and Port Antonio districts, on the north coast, are rather heavy clays, but the most profitable plantations are on soils of a loamy consistency. That described by the Government Chemist, Mr. H. H. Cousins (*Bulletin of the Department of Agriculture, Jamaica*, October, 1901), as the most ideal soil for bananas at Portland, contains such an enormous amount of humus and other plant foods, that it resembles a rich compost more than an ordinary soil, as shown by the following percentage analysis:—

Humus	9·86	
Moisture	24·86	
Organic matter and combined water	25·10	
Nitrogen	0·70	Calculated on the dry soil.
Potash	0·68	
Lime	1·38	
Phosphoric acid	2·76	
"Available" potash	0·0571	
,, phosphoric acid ...	0·0908	

Other soils from St. Catherine, Jamaica, growing bananas successfully, are reported by the same authority to contain, per cent.:—

Humus	1·79	1·54	Calculated on air dry soil.
Nitrogen	0·157	0·147	
Potash	0·38	0·43	
Lime	1·00	1·51	
Phosphoric acid	0·21	0·19	
"Available" potash	0·0518	0·0108	
,, phosphoric acid ...	0·0634	0·0695	

The analyses quoted [5] represent pretty well the extremes of banana soils, and good results obtained on the two last-mentioned soils, containing rather small amounts of humus, must be due to exceptionally favourable climatic conditions.

There can be no doubt, from all the evidence obtainable, that bananas require a well-drained, loamy soil, containing a fair amount of humus, and good amounts of potash, lime and phosphoric acid in readily available form.

With regard to the manuring of bananas the following remarks may be of interest.

Bernegan [6] states that the cultivation of bananas made enormous progress in Teneriffe, due to irrigation. The Cavendish variety is principally grown, planted 10 ft. apart, and heavily manured with dung (stable compost) and guano.

Artificial fertilizers, more particularly potash manures, give good results in the banana culture in India [7].

The most important crop cultivated by the natives of the Lake Victoria Nyanza districts is the banana, which receives the greatest care and the largest amounts of dung [8].

Lime is of very great importance to bananas, and experiments in Panama have proved the great benefits derived by the liming of soil in the cultivation of bananas [1]; this is also proved by our own manurial experiments.

Phosphoric acid is of value, but potash must be supplied particularly in liberal amounts. A number of fertilizer experiments reported by J. M. Hattrick [9], as carried out in Queensland and in Fiji, fully bear this out, and the author quoted states that for every 1s. spent on potash the planter received 6s. in return.

With regard to the conservation of humus in banana soils, it must be stated that a good deal is returned to the soil by tne leaves and stalks of the plant after the bunch has been cut. The method practised in Jamaica, to cut the stalk into small pieces, is undoubtedly to be preferred to the method generally practised in Queensland of chopping the stalk down, and allowing it to rot near the stool of growing bananas. It is stated [5] that one man can chop 100 stalks into small pieces in a day.

The growing of green manure crops, like velvet beans, Mauritius beans, etc., is practised in some localities, and can be strongly recommended, as long as the cover-crop is not allowed to grow too near the stools, so as to prevent robbing the bananas of the necessary moisture.

The only evidence of replanting old banana lands I could find refers to Costa Rica, where periodical inundations keep up the fertility of the soil [10]. In that country, as a rule, banana lands are replanted every six to seven years, but in some cases, with flooded lands, plantations fifteen years old give as good a return as in their second and third year; a porous sandy soil is preferred for banana culture.

Isolated cases of abandoned, old banana lands being replanted and yielding good crops, even without the aid of manuring, have been reported in Queensland. But I have no doubt whatever that the crops would have been much better, and certainly much more lasting, if fertilizers had been added, as nobody can dispute the correctness of Semler's statement [11] that "no other cultivated plant exhausts the soil to such an extent as bananas."

This statement is born out (1) by comparing the analyses of the soils from virgin land and exhausted banana land, in which the total amount of potash present is reduced by nearly one-half, and the amount of "available" potash remaining is less than one-tenth of that found originally (see soil analyses, Table III), and (2) by a study of the actual food requirements of the banana plants, based on the analyses of plants and fruits of the three principal varieties grown in Queensland, carried out in the Departmental Chemical Laboratory (see Table I).

From this investigation we learn that a crop of Cavendish bananas removes in a fair crop of fruit: 123 lb. of potash, 12·5 lb. of phosphoric acid, and 43·7 lb. of nitrogen; whereas the stalks left on the ground contain 150 lb. of potash, 6 lb. of phosphoric acid, and 41·4 lb. of nitrogen. Practically speaking, therefore, 273 lb. of potash, or about 5 cwts. of sulphate of potash, per acre, must be at the disposal of the banana plant in a readily available form, to produce its growth and crop in a few months.

At the time of planning the fertilizer experiments on exhausted lands, these figures were not available, and the manurial basis was fixed more or less arbitrarily, at K = 80 lb. of potash, P = 80 lb. of phosphoric acid, and N = 40 lb. of nitrogen per acre.

The results of the growth during the first year were so striking that the amount of potash was doubled in all further applications, thus making our standard fertilizer

TABLE I.

Analyses of the Ash of Banana Plants and Fruits, Grown at Buderim Mountain.

	Banana Plants						Banana Fruits					
	Lady's finger		Cavendish		Sugar		Lady's finger		Cavendish		Sugar	
		Pure ash		Pure ash		Pure ash		Pure ash		Pure ash		Pure ash
		Per cent.		Per cent.		Per cent.		Per cent.		Per cent.		Per cent.
Weight of green plant	118 lb.	...	52 lb.	...	62 lb.	...	...	...	...	...	...	...
Weight of bunch	...	...	...	...	...	...	22 lb.	...	39 lb.	...	16 lb.	...
Approximate number of bunches per acre	...	...	...	...	...	...	432	...	555	...	460	...
Moisture, per cent.	87·69	...	90·00	...	85·54	...	75·9	...	79·8	...	72·75	...
Dry material, per cent.	12·31	...	10·00	...	14·46	...	24·1	...	20·2	...	27·25	...
Pure ash, per cent.	1·14	...	1·31	...	1·14	...	1·18	...	0·94	...	0·92	...
Containing—												
Silica, SiO_2	0·270	23·68	0·201	15·34	0·245	21·49	0·082	6·960	0·059	6·225	0·063	6·923
Iron and alumina, Fe_2O_3, Al_2O_3 ...	0·015	1·32	0·023	1·77	0·021	1·88	0·033	2·835	0·010	1·112	0·037	4·061
Manganese oxide, MnO	0·026	2·32	0·023	1·77	0·021	1·88	0·001	0·119	0·002	0·200	0·001	0·115
Lime, CaO	0·219	19·24	0·278	21·33	0·151	13·25	0·039	3·324	0·020	2·125	0·018	2·016
Magnesia, MgO	0·064	5·66	0·092	7·02	0·100	8·77	0·071	5·995	0·056	5·925	0·056	6·091
Soda, Na_2O	0·050	4·44	0·021	1·60	0·022	2·00	0·033	2·815	0·018	1·880	0·023	2·506
Potash, K_2O	0·378	33·17	0·480	36·64	0·437	38·33	0·734	62·350	0·605	64·250	0·555	60·625
Sulphuric acid, SO_3	0·007	0·66	0·018	1·38	0·020	1·75	0·017	1·445	0·013	1·329	0·015	1·659
Phosphoric acid, P_2O_5	0·030	2·65	0·019	1·46	0·040	3·52	0·083	7·010	0·058	6·150	0·071	7·748
Chlorine, Cl	0·121	10·62	0·199	15·20	0·103	9·10	0·108	9·175	0·130	13·900	0·098	10·728
Nitrogen, N	0·107	...	0·133	...	0·136	...	0·212	...	0·202	...	0·304	...

	Lb. of Plant Food						Lb. of Plant Food					
	In each plant	In plants per acre	In each plant	In plants per acre	In each plant	In plants per acre	In each bunch	In bunches per acre	In each bunch	In bunches per acre	In each bunch	In bunches per acre
Lime, CaO	0·258	154·8	0·144	86·4	0·093	55·8	0·0086	3·73	0·0079	4·37	0·0029	1·36
Magnesia, MgO	0·075	45·0	0·048	28·8	0·062	37·2	0·0155	6·70	0·0217	12·03	0·0089	4·10
Potash, K_2O	0·446	267·6	0·250	150·0	0·272	163·2	0·1615	69·75	0·2360	123·09	0·0888	40·80
Phosphoric acid, P_2O_5	0·035	21·0	0·010	6·0	0·025	15·0	0·0182	7·84	0·0226	12·50	0·0113	5·21
Nitrogen, N	0·126	75·6	0·069	41·4	0·084	50·4	0·0466	20·15	0·0787	43·70	0·0486	22·38

for bananas to contain: K = 160 lb. of potash, P = 80 lb. of phosphoric acid, N = 40 lb. of nitrogen, applied per acre twice a year to normal crops, and in double quantities 2(KPN) to crops on exhausted lands.

For the experiments, two blocks of land at the two ends of the small fertile table-land on Buderim Mountain, where the land has been under cultivation for over twenty years, were chosen. The results of both series are practically identical, so that we need study only the results of one.

The soil is a porous, red volcanic loam of good depth, but at the time of preparing it for cultivation, so worn out that even weeds and grass would barely grow on it. The soil still contained, however, a good amount of humus (in all cases determined by Rather's modification of the Grandeau method [12]), and a good amount of total phosphoric acid and nitrogen, but was low in total potash and lime, and very deficient in "available" phosphoric acid and potash (see analyses Table III).

Each block was divided into two plots of one acre each, the first being planted in 1909, and the second in 1910, after being kept under a green-manure crop for the year.

The land was ploughed shallow at first, with narrow furrows, and harrowed and cross-harrowed several times, until all the couch grass and other weeds were removed. One month before planting the ground was ploughed deeply, followed by a sub-soiler working to a depth of 18 to 24 in. The ground was again harrowed and cross-harrowed, to get the soil into a good mulch, before making the plant holes in October. The bananas planted were of the Cavendish variety, the most profitable and also the hardiest of the dwarf varieties. The plant holes were made 12 ft. apart, giving 302 plants per acre, and twenty-eight stools to each experiment. The first lot of manure was applied in the plant holes, well mixed with the soil, before planting the suckers, and the subsequent applications were made as top-dressings, and were slightly hoed under.

I must here state that I believe it is better, in the case of old plantations, to apply part of the artificial fertilizers in holes, made with a crowbar to a depth of from 18 to 24 in., all round the banana stool, at a distance of from 3 to 5 ft., and the rest of the fertilizer as a top-dressing.

The Narico-bean, planted as a green-manure crop on the second plot, did not grow too well, although well manured, and this must have been due to the acid nature of the soil and want of lime. The crop was ploughed in and the second series of bananas planted September, 1910.

The results of the experiments, as shown by the yields (Table II), speak for themselves.

Rows 1 and 2, of the first series, may be left out of account, as the land at that point is a little low-lying, and suffered from heavy washaways during storms in the first year of growth, and the stools in these rows were also more directly exposed to the cold winter winds.

The unmanured and lightly manured rows showed from the very start want of vigour in the plants, and demonstrated clearly what to expect when replanting such depleted lands without artificial fertilizers; whereas experiments with double quantities of fertilizers gave excellent yields. A striking feature on poor land is the formation of so-called "blind bunches." The banana sucker, as soon as the bunch appears, seems to lose its vitality, the leaves drop off, and the stalk bends over, often breaks off, as if it had not sufficient strength to support even a small bunch of fruit. Most of the bunches in the unmanured and slightly manured rows were of this nature. The heavily manured plots produced good heavy bunches, many with fifteen and sixteen dozen bananas; the plants have a much healthier appearance, and are much more robust to withstand the severity of the cold weather during the winter months.

In my sixth Progress Report on the experiments (*Queensland Agricultural Journal*, June, 1913) I stated that the quantities of artificial fertilizers applied, can be well considered a world's record, as in some instances nearly 2 tons of artificial fertilizers are applied yearly, and the cost of the manure, 2(KPN), amounts to above £25 per acre, and in the case of experiments where lime was used in addition to the other fertilizers to a total of £29 per acre.

TABLE II.

Crop Results of Banana Manuring Experiments, on Buderim Mountain, Queensland.

1st Series.

No. of Experiment and Fertilizers used	Four Years' Crops		
	Total, Dozen	Total, Bunches	Average annual yield, dozen
	Per acre	Per acre	Per acre
1. (KPN_B)	5,393	625	1,348
2. $2(KPN_B)$	7,637	971	1,909
3. $\frac{1}{2}(KPN_B)$	3,047	528	762
4. Nil	442	86	110
5. $\frac{1}{2}(KPN_N)$	6,041	863	1,510
6. $2(KPN_N)$	13,650	1,489	3,412
7. (KP_TN_N)	10,204	1,262	2,551
8. (KPN_A)	7,750	884	1,937
9. $2(KPN_A)$	14,034	1,639	3,508
10. (KP_TN_A)	12,470	1,402	3,118

2nd Series.

No. of Experiment and Fertilizers used	Three Years' Crops			Crop 1913-14	
	Total, dozen	Total, bunches	Average annual yield, dozen	Dozen	Bunches
	Per acre	Per acre	Per acre	Per acre	Per acre
11. $2(KPN_B)$	9,799	1,165	3,266	4,700	496
12. $2(KPN_N)$	12,710	1,413	4,237	4,470	432
13. $2(KPN_N)$ + Salt... ...	10,435	1,284	3,478	4,530	485
14. $2(KPN_B)$ + Salt.	10,042	1,230	3,347	3,880	400
15. Nil	5,280	820	1,760	1,639	216
16. Nil + Lime	6,489	971	2,163	4,910	550
17. $2(KPN_N)$ + Lime ...	9,966	1,165	3,322	4,710	485
18. $2(KPN_B)$ + Lime ...	10,596	1,262	3,532	7,070	712
19. $2(KPN_N)$ + Lime + Salt ...	9,260	1,068	3,087	7,515	701
20. $2(KPN_B)$ + Lime + Salt ...	8,969	1,122	2,989	7,955	733

K = 160 lb. K_2O applied as 320 lb. Potassium sulphate per acre.
N_B = 40 lb. N applied as 290 lb. Dried blood per acre.
N_N = 40 lb. N applied as 290 lb. Nitrate of lime per acre.
N_A = 40 lb. N applied as 200 lb. Ammonium sulphate per acre.
P = 80 lb. P_2O_5 applied as 470 lb. Superphosphate per acre.
P_T = 80 lb. P_2O_5 applied as 470 lb. Thomas's phosphate per acre.
2(KPN) means double above quantities. $\frac{1}{2}$(KPN) means half quantities.
All manures applied twice a year, in spring and in autumn.
Salt applied 2 cwt. per acre. Lime applied in two dressings of 2 tons limestone screenings per acre.

The average yield of the experimental plots (KPN), taking the average of eight experimental plots for a period of three years, was 345 bunches, with 3,035 dozen bananas per acre per annum, at a value of say £38, the cost of the fertilizer being about £12 10s. per annum.

In the experiments 2(KPN) we obtained an average yield of 457 bunches, with 4,330 dozen, of a value of £54 per acre, showing a considerably increased net profit over the yield obtained from plots (KPN).

The record yield was given by experiment 12 in 1912-13 with thirty dozen per stool (second year's crop), the same plot yielded last year only 14¾ dozen. Experiment 20, which yielded 21¾ dozen per stool in 1912-13, gave in the last harvest 28½ dozen per stool. Very remarkable is the yield of the two unmanured plots (experiments 15 and 16), giving 11 and 17 dozen respectively in 1912-13, and last harvest, up to March, 1914, 5½ and 16¼ dozen respectively, showing clearly the influence of the long dry spell during the year 1913 on the limed and unlimed, unmanured experiments, and proving the great advantage of liming.

The owner of the experimental field also conducted on his own account an experiment with a commercial mixed fertilizer, frequently used for manuring in this district. Using this fertilizer at the rate of 6 lb. per stool, or 16 cwt. per acre, he applied, expressed in our standard, ¾ K 3½ P 1½ N, but the results were exceedingly disappointing, clearly indicating the want of potash in the mixture.

With regard to the application of phosphoric acid, it appears that both Thomas's phosphate and superphosphate give good results. In this class of red soil the soluble phosphoric acid changes soon into an insoluble form of sulphate. As superphosphates are more easily obtained, they were exclusively used for the second series of experiments.

Nitrogen acts apparently best in the form of dried blood, and as nitrate of lime.

The application of salt in addition to other manures does not appear to make any appreciable difference in the yields, and it appears that the plant gets a sufficient amount of salt from the ordinary class of soil.

In the close neighbourhood of the experimental field the head-teacher of the State School on Buderim Mountain carried out some manuring experiments with bananas, besides growing a large number of different varieties. The soil was a virgin soil of good quality, and the results of his experiments show that on a virgin soil the application of our standard (KPN), twice a year, gave the most profitable harvest. The incomplete fertilizer, without potash, did but barely pay for the application of the fertilizer, as compared with the unmanured plot, showing the importance of potash to the banana plants. The results of his experiments were as follows:

Application of manure	nil	(PN)	(KPN)	2(KPN)
Cost of manure per acre	nil	£9 8s. 6d.	£12 6s. 6d.	£23 4s. od.
Value of crop per acre	£28 11s. 9d	£39 3s. od.	£67 2s. 3d.	£55 15s. 2d.

Of particular interest to the agriculturist will be the question, how such heavy manurial dressings affect the physical and chemical properties of the soil. New samples of soil were taken after the experiments had been in progress for four years. One sample was obtained from the unmanured row 15, another was taken from the heavily manured row 12, a few feet from the stool, at places where the fertilizer was actually applied. Another sample was taken between the unmanured rows 15 and 16, and lastly a sample was taken between the heavily manured rows 19 and 20, where lime was applied, but outside the zone of artificial fertilizer. The last sample shows clearly that the manure does not spread its effect to any distance and that the plants evidently utilize it as soon as it is applied. In row 12 only do we find a distinct increase in the amounts of available plant food (see Table III).

The physical conditions of the soil were improved by cultivation and manuring, and the soil is now in excellent condition, capable of producing good crops, as the plants are enabled to utilize the fertilizers easily.

The owners of the experimental fields are quite convinced of the profits derived from the application of our

TABLE III.

Analyses of Banana Soils from Buderim Mountain.

Volcanic dark red sandy loam.

		Soil from adjoining virgin land	Average sample of soil from experimental field before planting	Soil from unmanured row No. 15	Soil from manured row No. 12	Soil taken between unmanured rows Nos. 15 and 16	Soil taken from limed portion between rows Nos. 19 and 20
Date of analysis...	...	13.3.1909	13.3.1909	31.12.1913	31.12.1913	16.3.1914	16.3.1914
Reaction	...	acid	acid	slightly acid	acid	acid	slightly acid
Water capacity ...	...	52·4	46·0	52·7	51·5	—	—
Capillarity after 3, 6, 24, and 48 hours	...	9, 12, 14½ in.	4, 5, 9 in.	12½, 17, 20½, 22¾ in.	11, 15¼, 17, 18¾ in.	—	—
Mechanical analysis of fine earth—							
Fine gravel, from 1 to 2 mm.	per cent.	—	1·07	0·88	0·69	—	—
Coarse sand, from 0·5 to 1 mm.	„	—	2·54	4·11	3·59	—	—
Medium sand, from 0·25 to 0·5 mm.	„	—	26·14	24·23	17·59	—	—
Fine sand, from 0·05 to 0·25 mm.	„	—		14·38	14·25	—	—
Silt, from 0·02 to 0·05 mm.	„	—	13·16	7·02	13·14	—	—
Fine silt, from 0·01 to 0·02 mm.	„	—	3·33	7·26	1·59	—	—
Clay, under 0·01 mm.	„	—	28·76	22·05	21·87	—	—
Organic matter and water	„	—	25·00	23·07	27·28	—	—
Chemical analysis of fine earth—							
Moisture	per cent.	6·34	7·96	7·45	8·14	15·58	13·82
Humus	„	18·86	17·04	3·62	3·60	2·89	2·99
Other organic matter and combined water	„			11·97	15·28	12·61	12·91
Nitrogen	„	0·560	0·292	0·314	0·325	0·224	0·213
Chlorine	„	—	—	0·0075	0·0050	0·0080	0·0060
Phosphoric acid	„	0·255	0·338	0·160	0·204	0·164	0·186
Lime	„	0·450	0·180	0·260	0·260	0·282	0·407
Magnesia	„	0·310	0·310	0·141	0·129	0·146	0·127
Potash	„	0·109	0·067	0·085	0·127	0·065	0·070
Insoluble in HCl (sp. gr. 1·1)	„	37·72	31·89	32·22	31·99	29·08	30·68
Soluble in 1 per cent. citric acid: Phosphoric acid	„	0·0142	0·0034	0·0026	0·0046	0·0016	0·0014
Soluble in 1 per cent. citric acid: Lime	„	—	0·0830	0·1380	0·1510	0·0900	0·1020
Soluble in 1 per cent. citric acid: Potash	„	0·0400	0·0035	0·0052	0·0312	0·0061	0·0068

complete fertilizer, and are continuing and extending the use on these and other areas under bananas.

In conclusion I feel justified in stating that an application of the principles evolved from our manurial experiments to other areas of old banana lands, in this State and elsewhere, would lead to a considerable expansion of this important industry, and that it will be found that most of the old lands, all of which are in easily accessible localities, will give profitable returns.

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[3] Dr. GROTEWOLD: "Bananenbau, u.s.w.," *Tropenpflanzer*, 1910, p. 571.

[4] H. C. HENRICKSEN: "Bananas in the West Indies," reprint from *Tropical Life*, 1909.

[5] Hon. W. FAWCETT: "Banana Industry in Jamaica," *West Indian Bulletin*, No. 2, vol. iii.

[6] L. BERNEGAU: "Reisebriefe aus den Subtropen," *Tropenpflanzer*, 1904, p. 221.

[7] Dr. VAGELER: "Ueber Kalidüngung, u.s.w.," *Tropenpflanzer*, 1908, p. 77.

[8] U. v. KATTE: "Die Wirtschaftlichen Verhältnisse am Viktoria-See," *Tropenpflanzer*, 1908, p. 513.

[9] J. M. HATTRICK: "Manuring of Bananas," *Queensland Agric. Journ.*, May, 1912.

[10] "Bananenkultur in Costarica," *Tropenpflanzer*, 1905, p. 661.

[11] H. SEMLER: "Banane," *Die tropische Agrikultur*, Bd. ii, 1900, p. 196.

[12] "Rather's Humus determination," *Journ. Indust. and Eng. Chemistry*, September, 1911.

MISCELLANEOUS SUBJECTS.

THE KARAKUL SHEEP, THE PRODUCER OF "PERSIAN LAMB" AND OTHER FURS OF OVINE ORIGIN.

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The Karakul sheep are the best fur-producing breeds of the lofty plateaux of Central Asia. Their home is in the arid region in Western Russian Turkestan, comprising the Kizil-Kum and Kara-Kum deserts and the Khanates of Bokhara and Khiva. This district is situated east of the Caspian Sea and north of Afghanistan.

When the European Russian, who goes to Kara-Kul to buy fur-bearing sheep to produce so-called "Persian" and "Astrakhan" fur, speaks of Karakul sheep, he refers to all good fur-producing sheep in Bokhara, but the term is not used locally in Central Asia. The universal names are Arabi, Duzbai, and Shiraz. The first seems to indicate that this breed was first introduced from Arabia, although neither history nor the Arabian sheep of to-day support the assumption. The name Karakul (meaning in Sart "black lake") refers to the lake in the town of the same name on the lower Zarafshan, in Bokhara, which is an important centre of the lamb-fur and sheep-skin industry. The Kara-Kum desert is extremely barren, consisting of sand dunes and saline steppes covered with "Saxaul" (*Haloxylon ammodendron*, Bunge), a thorny chenopodiaceous scrub, and where there is no drifting sand and the soil is clayey in nature, a little grass in spring. During the summer it is very hot and there is little rain, while in winter the temperature falls below zero. Under such trying climatic extremes it is little wonder that the Karakul sheep have earned the reputation of being perhaps the hardiest of all domesticated animals.

Origin of the Breed.

There is no subject in which there is more confusion with regard to facts in general, including classification, than that of Asiatic sheep. Towards this state of uncertainty there are several contributary causes. Military considerations forbid exploration in Afghanistan and in important regions of Bokhara under Russian domination. Moreover, neither the ancient nor the modern authorities have properly differentiated between the two great branches of the ovine race which supply the preponderating numbers in the vast hordes of sheep of Western Asia—the fat-rump or "Kurdiuk" type[1] (*Ovis steatopyga*), and the broad-tail type (*Ovis platyura*). The term "broad-tail" in the fur trade, as will be explained later, is correctly applied and confined to a specific variety of lamb-fur.

The Karakul breeds are correctly classified as a type of the true *O. platyura*. They also belong to the variety of long-tail, the fatty accumulation being of a roughly triangular form, with the apex pointing downwards on the base of the tail and joining on to the region of the rump—described by Pallas as "thick and fat above but long and lean below." There is equal uncertainty with regard to the origin as with regard to the classification of Asiatic sheep.[2] There seems to be sufficient presump-

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[1] "Kurdiuk" in Tartar means a hanging fat sack.

[2] Dr. C. C. Young of Charlottetown, P.E.I., Canada, writing from Kishinev, the capital of Bessarabia, South-West Russia, on June 28, 1914, says: "All Karakul breeds belong to the class of *Ovis platyura*, called in Russian 'Shirokochvostaja ovtsa'; in German this means 'Breitschwanz,' and in English 'broad-tail.' They have from eighteen to twenty-four vertebræ surrounded by fat, except Cocey Cross (*sic*), and are the result of the cross of the fat-rump, *O. steatopyga*, also called Kurdiuk or long-tails. Fat-rumps are called 'Fettsteis' in German. There are no fat-tails in the area under consideration: the Russians call them 'Jirnochvostaja ovtsa,' in German this means 'Fettschwanz,' and in English 'fat-tail.' A fat-tail is a long-tail with a little extra fat. The fat-tails are not fur-producers unless one is willing to consider the Tshushka, Reshetilev and Malitch (Russian breeds) as such. They are descendants of the long-tail Danadar, from which *all* Karakul breeds (Arabi, Duzbai and Shiraz) descend. The latter three kinds are broad-tails, because they contain fat-rump blood!"

tive evidence to justify the assumption that the wild Mongol Argali (pronounced "arkal" by the natives) *O. ammon* (or *O. musimon* of Pallas),[3] with its very short tail and dark greyish ruddy-brown winter coat, consisting of very fine wool "mixed with hair, everywhere 1½ in. long at least, concealing at its roots a fine woolly down of white colour," is at least the ancestor of the most numerously represented and widely distributed section, the fat-rumped, *O. steatopyga*, which is reported to be wilder than its compeer broad-tail.[4] This assumption is supported by the observations of Douglas Carruthers, who in 1912 discovered at two places in Western Turkestan, viz., Adishan (72° E. long.) and Hissar (68° E. long.), that wild rams, believed to be *O. poli*, although not of the gigantic variety, had been captured and were kept in confinement to mate with domestic sheep to strengthen their constitutions, often a very necessary counteraction to the indiscriminate commingling and in-and-in breeding which goes on in an unfenced country, especially where sheep are herded in small flocks. Authorities, however, are not at one on the point, for Lydekker says:[5] "It is more probable that the Urial, *O. vignei*, was the ultimate ancestor of the fat-tail and the fat-rumped groups, both of which were almost certainly differentiated from a common domesticated stock."

Some of the characteristics by which the flocks "of all

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[3] Identical with the *O. poli*, Blyth, a sheep furnished with gigantic horns found by Marco Polo in its greatest perfection on the *Pamirs* of the mountain midrib of Asia, viz., lofty valleys between ranges of hills, and with floors more or less flat, but nowhere more than five or six miles wide and often much less, "covered with pasture so luxuriant and nutritious that if horses are left on it for more than forty days they die of repletion." "Marco Polo," p. 178. (Translation by Sir Henry Yule. Third edition, revised by Henri Cordier.)

[4] With this view Dr. C. C. Young disagrees, arguing that "the Argali being a mountain sheep has no need for any fat pillows, nor has any other mountain sheep. The Mamai is a fat-rump, probably the original *O. steatopyga*, the wild desert sheep."

[5] "The Sheep and its Cousins," 1912, p. 193.

the Tartar hordes (of the eighteenth century) resembled one another" were similar to those of the fat-rumped sheep of to-day, though varied locally then as now, by the influences of soil and climate. These were: "long hanging ears"; "tolerably fine wool, mixed with hair,"[6] the colour of the most typical usually fawn tinged with red or, when more alien blood is present, grey of the blue-grey type, darker towards the extremities; the horns of the ram "large, spiral, wrinkled, angular, and bent in lunar form"; "a solid mass of fat on the rump, falling over the anus in place of a tail, and dividing into two hemispheres, which take the form of the hips with a little button of a tail in the middle; the atrophied tail consisting of three or four vertebræ, not more than 2 to 3 in. long, no thicker than a man's middle finger, straight, standing out or turning up, and covered with stiff hair like a pig's bristles."

The largest and most typical of a number of varieties is the red Kalmic fat-rump, said to be "the heaviest of all domestic sheep," with a very large head and prominent Roman nose, the posterior fat extending below the hocks and weighing from 20 to 40 lb. They are strongly built, and the soles of the hoofs are hollowed for the purpose of removing snow to get at food in winter, but probably also to give a surer footing on bare rocks, like the hoofs of the yak. Among the prominent fat-rumps which *per se* are not fur-producers may be mentioned the Kalmic, Kirghiz, Mongol, Burat, Achuri and Chulmi, besides Caucasus and Bokhara "Kurdiuks." What is known as Kirghiz and Kalmic butter is the soft fat obtained from the rumps of the sheep under discussion and from the tails of fat-tail breeds, and which differs fundamentally from the hard stearine fat or suet of European sheep.

Although Karakuls are regarded as the best and most typical of the broad-tail class, other varieties are worthy of mention, viz., Malitches, Piranyas, Valoshskaya, Kara-

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[6] C. C. Young insists "that the original *O. steatopyga* had no fine wool, those having it now are mixed with Afghan fine-wools." If the description in the text is correct, mixing must have begun at an early date.

chaev, and Tushinskaya. "The Karachaev is said to be even better than the Karakul when it comes to mutton."

The Karakul sheep of the Duzbai order, which, like all Asiatic sheep, is not an absolutely pure breed, now produces the best fur since the disappearance of the historical Small Arabi. Plates I and II[7] show types of Karakul sheep.

Characteristics.

The Karakul-Duzbai is a large sheep, altogether black at birth, with the possible occasional exception of a white spot on the forehead or a white tip to the tail. As a rule the ewe is hornless, and the ram generally, though not invariably, carries horns of moderate dimensions, which fall short of making a spiral turn. The head is long, somewhat narrow, with a high arching nose descending abruptly to the muzzle and giving it something of a tapering appearance, partly the result of the shape of the nostrils, the lips of which are folded in and contracted rather than expanded, evidently as a natural precaution against driving sand. The ears are of medium length and pendant, as is the rule with the ears of most domestic animals of the tropical East. The bone is strong and clean, the legs tight and well formed, and the feet large. The movement in walking or running is free and active, and the carriage gay. The withers are high and sharp, the loins broad, and the hindquarters low, short, and markedly drooping. The characteristic tail "tapers into a noticeably twisted end," the broad, flat, fatty base sometimes weighing as much as 15 to 20 lb. in full-grown rams. The store of nutriment in the tail is akin to the reserve provided by the hump of the camel and of the zebu race of cattle, and being drawn upon for sustenance in cases of emergency it enables an animal deprived of food and water to subsist for many days. The characteristics of a Karakul-Duzbai may be seen in Plate II.

When the Karakul-Duzbai is crossed with European sheep there is a wonderful increase in weight, owing to

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[7] The illustrations accompanying this paper appeared in an article by Professor Wallace in the *Journal of the Board of Agriculture* for August, 1915, and are reproduced from blocks kindly lent by the Board.

the preponderance of the fat-tail blood. Karakul mutton is of excellent gamey quality, free from the sheepy flavour that is specially characteristic of a full-grown Cotswold, and to a less degree of many other essentially fleshy long-wool British breeds. The famous Tartar "shashlik" is made from the flesh of the Karakul as well as of the fat-rumped Kurdiuk and Karachaev in the Caucasus. Its superior tender quality has been recognized in America for some years. Colonel Charles Goodnight, the well-known bison breeder, had a flock, recently sold, of about 150 Persian fat-rumps of a Danadar strain. He is reported to have had a contract with certain stockyard people to pay him about £2 10s. for each lamb when old enough to kill, on the mutually admitted fact that the mutton was superior to that derived from either American or British sheep.

Karakul ewes sometimes breed twice in the year; but, except when placed under exceptionally favourable circumstances, this is a severe strain on any breed of sheep, and is not general. Some produce twins and triplets. The lamb has for about three days a close lustrous fur (Plate IV), which afterwards becomes loose and open and grows in length. At about the third month as a rule, a fleece, still quite black, of straight wool has developed in the ram, but it begins to turn grey about the sixth month.[8] The hair-like wool becomes long and strong, although it still retains much of its lustre and is useful for the manufacture of coarse fabrics, including carpets and rugs. The similar wool of ewes when of highest quality retains for a longer period a remnant of the early curly condition in loose and open locks.

Production of Fur.

The most essential feature of the wool of the Karakul sheep as it ought to be, is the complete absence of the undercoat of fine downy wool belonging to Afghan fine-wool sheep. The jet-black, tight curling, lustrous fur of

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[8] Dr. Young, going into greater detail, says: "If it contains fine wool, which most do, then at the end of the second month fine wool will turn brownish, and later the coarse longer hair will oxidize grey."

PLATE I.

Types of Karakul Sheep.

Fig. 1.—*Left:* Shiraz Ram; *Right:* Duzbai Ram.

Both purchased near Kara-Kum, Bokhara, and sent to Prince Edward Island.

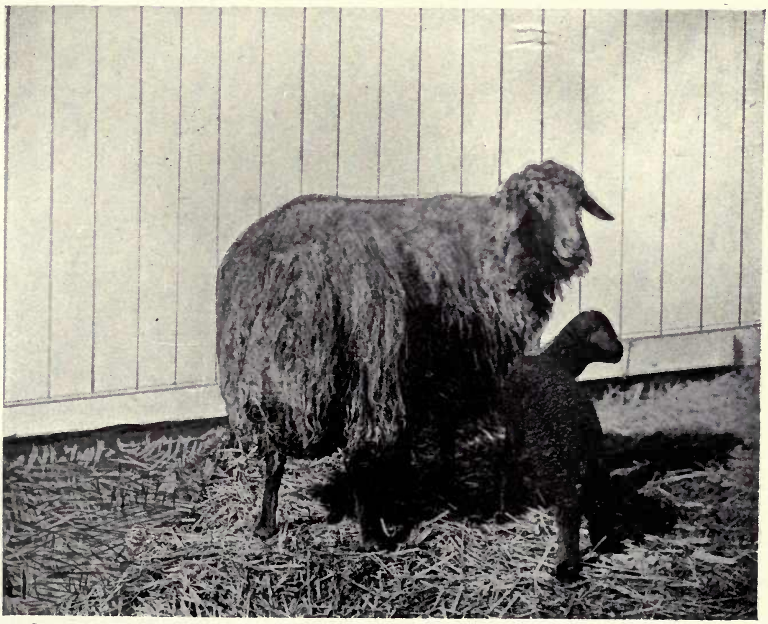


Fig. 2.—Karakul Ewe and Lamb in Prince Edward Island.

PLATE II.

Types of Karakul Sheep.

Fig. 1.—Karakul-Duzbai Ram at the Farm of the Edinburgh and East of Scotland College of Agriculture.

Fig. 2.—Head of the above Ram.

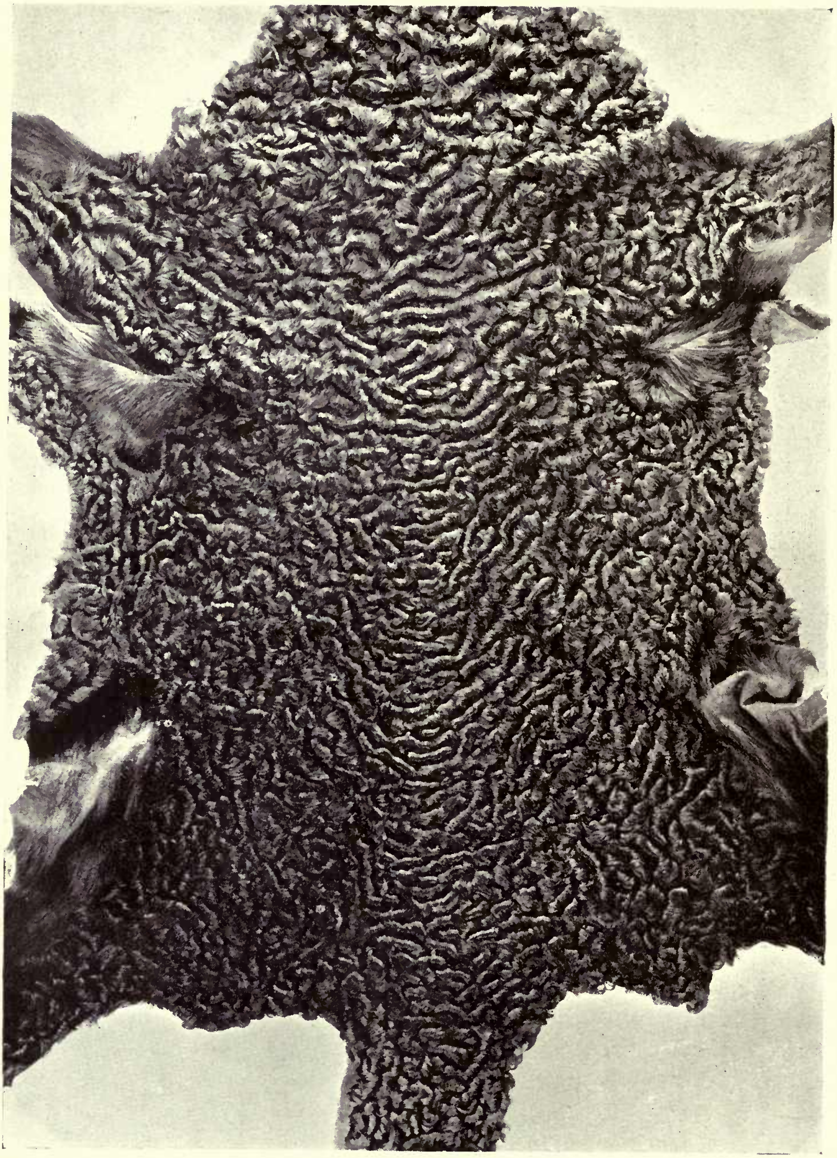
PLATE III.

Cross-bred Karakul Lambs.

Fig. 1.—Cheviot Ewe and her Karakul Cross Lamb, showing a very poor type of Fur.

Fig. 2.—Blackface Ewe and her Karakul Cross Twin Lambs, 3 days old.

PLATE IV.



A "Persian Lamb" Fur of exceptionally fine quality, taken under 3 days old.
The photograph was lent by Mr. Ernest Poland.

the newly-born lambs is the most important characteristic of the breed, and, with one exception, is the most valuable commercial product. This fur is misleadingly called "Persian Lamb" in the trade. The name is supposed to have arisen through the fur first finding its way into the Russian market through Persian traders, who, being Mohammedans, could go to Bokhara, where Christians would not have been allowed. Another explanation is that in past times, when travelling in certain Asiatic countries was more difficult or impossible to many, merchants brought the pelts of these sheep to the Nizhni Novgorod fairs, and, in order to keep the sources of their supplies secret, gave the lamb-skins a misleading name. The correct geographical name ought to be "Bokharans," as none of the lamb-skins came from Persia until about twelve or fifteen years ago, when a few of very inferior quality appeared.

The value of the "Persian Lamb" skin depends (1) on the form and tightness of the long, pipe-shaped curl, the points of the closely knit locks in the finest specimens being turned in so that few ends appear on the surface; (2) on the beauty of the pattern formed by the irregular yet artistic arrangement which, along each side of the back-line, often takes the form of delightful natural unrestrained bars; and (3) on the thinness or fineness and softness of the hair or wool, together with its great brilliancy. Plate IV shows an exceptionally fine "Persian Lamb" fur, while Karakul and cross-bred lambs possessing skins of various qualities may be seen in Plate I, fig. 1, and Plate III.

"Persian Lamb" skins have a length of about 20 in., and come to the market in an air-dried, raw condition, the value of first-grade skins being £1 10s. each, imperfectly curled skins being very much less, down to a few shillings, or even pence. The best skins are produced by lambs killed within seventy-five to eighty hours after birth. The small size then to some extent counterbalances the money value of the superior quality and tightness of the curl.

Although the skins can easily be separated into a few lots according to their market value, the individual variation is so great that out of hundreds, or even thousands, it is practically impossible to find two skins that exactly match. There are broadly three divisions according to the size of the curl—small, intermediate, and large. In Russia the intermediate curl is most prized, other factors being equal, which is contrary to the rule with grey Krimmer, in which the small curl is most rare and most valuable. Considerable variation in the size of the curl appears in different offspring from the same parents, and by some this has been attributed to feeding, though, like the colour and quality of the hair of some of our domestic animals in this country, it is probably due to natural constitutional variation.

The low average price of a large quantity of skins shows that an enormous number of inferior sheep are kept which ought to be capable of grading up. In 1905 one Leipzig house bought in Bokhara 385,000 skins at 16s. each. Dr. C. C. Young asserts that the quality has declined 85 per cent. in ten years! There is much scope for improvement by means of scientific breeding, and it may freely be asserted that over-production of high quality furs is quite impossible. Great havoc to the flocks is occasionally caused by blizzards and snowstorms, which occur irregularly, and in certain seasons give rise to a disease called "djut," which results in abortion.

The so-called "Broad-tailed" fur, which presents a fine, short, straight, figured, velvet-like hair of glossy black and great lustre, preserved by careful dyeing, with a beautifully figured water-mark through it, is identical with the curly "Persian Lamb" fur derived from a good Karakul-Duzbai, but is obtained at an earlier stage of development. The pelts are in consequence scarcely half as large, although often more costly, ranging in price from £1 10s. up to £3 each. The skins are those of prematurely-born lambs thrown by the ewes that suffer from "djut," and although brought into the world alive, the lambs, generally, are so frail and weak, that they would certainly die within a few hours. It is necessary to kill, bleed, and skin them as quickly as possible to preserve the quality of the fur and the wearing power of the skin when cured, as well as to prevent injury to the skin when pulling it off, which might easily reduce its value by 50 to 75 per cent. At the best the skins of "slinks," although often very beautiful, are fragile and have little wearing power, being liable to crack during use. Even the best "Broad-tail" skins, although much more costly, fall far short of the durability and wearing quality of "Persian Lamb" skins. Very few are of great value, as, if not got at the critical stage of development, the lustre and figuring which confer the special value on the skin are wanting.

The unpleasant "baby-lamb" story, to the effect that the mothers are slaughtered before the lambs are born to secure broad-tail skins, is entirely without foundation in fact. It was denied in Dr. James Anderson's volume of "Extracts from Dr. Pallas's Writings from Personal Knowledge Dealing with Sheep," published in this country in 1794. In spite of repeated authoritative confirmations of the denial by the Thorers of Leipzig and others, the error cropped up again a few years ago and did no little injury to the fur trade, as wealthy sentimental customers were dissuaded from investing in broad-tail garments as a protest against the supposed cruelty. As has just been explained, the origin of these skins is, and has always been, due to natural causes which need not give anxiety to anyone. The fact, which might have occurred even to the uninitiated, is that the ewe, now worth 80 to 100 roubles,[9] is infinitely more valuable for breeding purposes than her progeny at that early age would be though its skin might realize 15 roubles. Only a small proportion of the saleable skins of prematurely born lambs have a high commercial value. Owing to the hardy constitution of the breed the ewes usually recover. The lambs are killed in the ordinary way, mainly but not exclusively for their skins, for the Khirgiz use the flesh for food.

There are three ways of preserving lamb-skins in preparation for transit: (1) Drying them, by toggling without stretching, when quite green, in a shady place away from the direct influence of the sun; (2) salting them and placing them for a night in heaps of pairs with the green

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[9] 1 rouble = 2s. 1½d.

sides put together, the surplus salt being shaken out in the morning and the skins exposed to dry; and (3) in Bokhara, pickling them in coarse barley flour by a patent process in high favour with certain pickling firms, who guard their secret carefully.

In Asia "Persian Lamb" skins are never dyed, and those most directly descended from the fountain head of blackness retain their colour without fading into brown when exposed to the sun, as the black wools of English and Australian sheep are liable to do. In Europe and America all black lamb-skins are dyed black to make certain that the colour will not fade and also to intensify the natural lustre. No mode of dyeing will, however, give lustre to a wool which is not by nature lustrous. It is this inexplicable quality of lustre which has brought lamb-fur into fashion, and is the infallible guarantee that public appreciation is of a permanent kind.

Skins with tight grey curls are very rare and bring from £2 2s. to £5 5s. each; they are classed as Shiraz. Grey Crimean ("Krimmer") skins are used for the requirements of the private soldier, and in the other parts of the world for ordinary fur purposes. The curly locks are somewhat large and more open than those of "Persian Lamb," although there is great variation in this particular, due to the amount of fine-wool blood present in the producing sheep. The wool of Grey Crimean sheep is uniformly grey and its origin can only be conjectured. The sheep have been in the Crimea for half a century, and are supposed to have come from Bokhara via the Caucasus.

Not infrequently may be seen Karakul fur in which grey hair is intermixed. Local fur dealers call it grey "Shiraz." Young thinks this is a remnant of the grey Danadar. Of late years this fur has been worn as caps quite extensively by rich noblemen of Moscow and Petrograd. Grey lamb-skins when dyed do not develop the lustre or take the dye so satisfactorily as black skins of similar quality, though the dark brown skins do.

Kalmucks and Kirghiz in Astrakhan raise the huge fawn fat-rumps and cross them to all grades of Bokharan fur sheep, and produce the so-called "Astrakhan" fur or "Treibel," which may be glossy black, brown, white, or mottled; and flat to short-furred, wavy to moire. Medium haired sorts are more curly and wavy. The wide variety in type of fur and colour is the result of the great diversity of mixed breeding.

The so-called "Tibet" lamb skins do not come from Tibet, but are probably the product of sheep bred in North China, in the Provinces of Shansi and Shensi. The misleading name probably arose in China, where the word "Dhan Pik," meaning lamb-skin, may have been confused with "Tanpi" or Tibet. The dressing of Tibet lamb skins is not carried on locally by the breeders, but in large dressing establishments where hundreds of workers are employed.

The origin of the dark pigment in Karakuls and other strains of Asiatic sheep is believed to have been the Black Danadar, which is now practically extinct in Bokhara, though a few grey Danadars still exist near Kedjumek, where Dr. Young found a Black Danadar long-tail ewe, due to atavism, among the greys. The Black Danadar always remains black from youth to age, not becoming grey, as do the Arabi and Karakul-Duzbai. Quite a number of black sheep found by Young in Afghanistan, called "Gadik," and others in Tibet, strongly resemble the Danadar. There the skins of lambs are not used, but only the skins of older sheep, the wool of which remains black, lustrous and curly, although owing to the admixture of fine wool it has not the tightness which Europeans value so much in the lamb-skin. In a great many of the so-called Arabi sheep in Khiva, also the Karachaev of the Caucasus, both of which strongly resemble the Danadar, and a few of the Karakul-Duzbais, the colour of their pigment does not change through age. The Black Danadar, the "Look Nakbo" of Tibet, according to Young, is a small sheep, with a small head, small erect ears, small thin feet, and long tail reaching to below the hocks. Its wool is very lustrous, strong though not coarse, and wavy in the adult, the wool being shorter than that of the English long-wool. The curls of the new-born lambs are very fine in texture, but are not specially tight.

Fifty years ago a few Danadars were bought for Turkish, Persian, Russian, and German Royalties, but as the demand increased they were crossed with the white fine-woolled Afghan sheep, and thus was introduced not only fine under-wool, which is the bane of the fur trade, but white pigment, which most probably accounts for such grey-furred sheep as the Grey Danadar, Shiraz, Malitch, and Sokolief. The Danadar, like the Karachaev, is said to possess wonderful mutton qualities.

As the Karakul-Afghans represent probably 85 per cent. of all the Karakul sheep of Bokhara, it is fortunate that most of the little white fine-wool Afghans show traces of the fat-tail strain, such as a fat tail, thick feet, pendulous ears, concave nose, and coarser wool underneath the outer fleece. At times the Black Danadar strain in the Karakul-Duzbai is so slight that the animals come reddish-brown, the characteristic sign of the most typical Kurdiuk breeds. Occasionally there is a slight strain of Danadar in the brown fat-tail, and the lambs come with beautiful tight glossy round curls. Without this strain no fat-tail lambs are believed to come with tight curls. The same is true in the case of certain white Kurdiuks that come with curls, although the Danadar strain is so remote that the lambs are white. .Atavism appears now and then to bring back in complex crosses distantly connected colourings; for example, a brown may be born of black parents.

The employment of Karakul lamb skins for fur in the Western world is not as old as many suppose. In 1848 the firm of Rödiger and Quarch was the first to begin the importation and dyeing of "Persian Lamb" skins, and there was considerable doubt for a time whether the undertaking would become a large special industry. Only at the opening of the sixties M. Brass, of Berlin, began the pioneer work of manufacturing ladies' jackets from Persian, Krimmer (Crimean), and Astrakhan skins, which developed a great demand. At first the skins were edged with fringes of Angora goat hair.

The decrease in the numbers of the more valuable sorts of wild fur-bearing animals and the high prices of furs, together with the demand for a good wearing fur at a moderate price, necessitate the extension of lamb-fur production.

Although a good many skins are treated in the United States and Canada, Leipzig is the chief world's centre where lamb-skins are dressed and dyed for the market. It was claimed that, just as the atmosphere of Manchester or Lancashire is suited for the production of certain classes of cotton goods, so the climate, water, or other natural conditions, apart from the skill of the workers, put Leipzig before all other competing centres. This idea has now been upset by American results on an extensive scale. The European trade is in the hands of a few large firms, several of which possess a preparing factory and dye-works and capital to deal with sufficient quantities of skins to permit of proper sorting according to the country of their destination. Many skins intended for Russia are first sent to Leipzig in their raw condition, and the manufactured article is returned to Russia in spite of a high tariff. Skins are now treated in Moscow with most satisfactory results.

Instance may be given in which places become noted for specialities in the skin trade. Prague and Budapest take a foremost place in the trade in furriers' sheep and furriers' lamb-skins through the long-established firm of N. Troller Sons, who handle 400,000 skins each year. On the other hand, Vienna is the chief place for dressing lamb-skins for glove work. There exist many local markets in Germany for sheep- and lamb-skins which mostly handle German produce, but many Berlin firms carry large stocks of Oriental and imported lamb-skins. The suburbs of Gesundbrunnen is the centre of the white-dressing of lamb- and kid-skins for glove work, whereas the dressing of sheep-skins is chiefly found in Saxony and South Germany. Imported sheep-skins, such as those from Australia, The Cape, South America, India, North Africa, and Arabia, mostly come to auction in London. Although Germany and Austria take the lead in the dressing of sheep-skins exported as prepared leather as well as furriers' sheep-skins, the chief market for goat-skins is New York, and next to it France. Germany is far behind in the dressing of goat-skins, although chromedyeing has made great advances, especially in South Germany.

The Karakul Sheep Industry in Bokhara.

The Karakul sheep industry centres in the foothills of the mountains that form the southern boundary of Bokhara, the cultivable land in the valleys being utilized for gardens and orchards. The flocks are driven in autumn, when the first snow falls, from their summer quarters on the higher plateaux into the "Kishlaks" of the valleys. They are kept there until the lambing season is past, and in early spring they are driven back to the higher desert grazings, which are unsuited to cultivation. Their first destination from parts within range are the steppes of Karshi to the S.S.E., the earliest to become green. They do not go to the higher mountains, but are confined to the saline country, and are moved about at different seasons to the plains, valleys, and steppes, where and when food is most abundant. To enable the Karakul flocks to utilize the bushes and dry grasses of the steppes they must hunger from other food at times for fourteen days and even longer when snow covers the ground. The practices of to-day are, to all intents, those described by Pallas. The sheep are kept always in the open, and during winter more or less protected from the cold winds in the hollows of the mountains, and live mostly on dry stalks kept clear of snow by the wind.

To give their lambs a good start in life, the lambing season is regulated to come when there is an abundance of plants and flowers to develop the plentiful supply of milk that the ewes are capable of yielding. The time of lambing is determined by tying an old rag round the belly of the rams to form a screen, after the fashion practised on the Indian Deccan with supernumerary young bulls. In Bessarabia the proper breeding time is about the end of October, and lambs come early in the following March, after the danger of late frosts and snows is past; but in Bokhara the lambing season extends from January to May, with the busiest period in March and April. One ram unattended may not suffice for more than thirty to fifty ewes during the season on account of the difficulty presented by the ewes' fat tails, but when rams are properly looked after coupling becomes more certain and one ram may settle seventy females. A ram can remain in service for from eight to twelve years, and ewes live from seven to ten years. The liberal supply of mothers' milk in youth, and the abundance of "saline bitter pastures" combine to develop in the Karakul-Duzbai a big sheep, the ewes often weighing 200 lb., and rams over 300 lb.

After midsummer the lambs kept for breeding are weaned. The ewes continue to give a considerable quantity of rich delicious milk till late in the autumn. The famous "Brinza" cheese, described as "the pride of Southern Asiatic Russia," is made from it, to the amount of 30 to 40 lb. from each ewe. Brinza cheese is much finer in flavour than the cheese produced from the milk of the common sheep of Bessarabia, Moldavia, or Greece, and most of the so-called "Koshkoval" goes to Italy, where it is utilized in the flavouring of spaghetti, for which Italy is noted. "The people of Bokhara claim that the milk from Karakul sheep is the richest and most nourishing obtained from any living animal, and, in addition, it is supposed to contain anti-tuberculous properties. Tuberculosis is absolutely unknown among the natives of Bokhara," and a diet consisting entirely of Karakul milk, mutton, Brinza and "lepeshki" (native bread) is held to be an infallible cure for the disease when affected persons come to the country.

The large formation and dimensions of the soft oily tail fat are attributed to the abundant supply of salt, not only in the substance of the desert plants, but imbibed with the brackish water and with the dew which sheep lick from the surfaces of the herbage when drinking water fails. Much of the fat accumulation is lost in winter and during periods of scarcity, and when Karakul sheep are bred in other regions of Asia not so favoured as the Khanate in question in natural food supply, it has been noticed that the fat tails do not develop so perfectly. This gave rise to the common, although now acknowledged to be erroneous, impression expressed by Pallas and others following him, that the Karakul is liable to lose its fat-tail characteristic when bred in a strange country. The dictum does not hold good when abundance of food and sufficient salt is provided to permit of normal development. Apart from the unique combination of desert food-plants which has built up a breed of more than average size and outstanding quality among sheep, the abundant supply of salts has been a guarantee of freedom from internal parasites, which must be regarded as an important contributory influence. This asserted sudden departure from an ancestral characteristic as a result of the change of environment—a phenomenon often observed in connection with the unstable quality of colour in sheep—was disproved in relation to the physical form of the sheep by Professor Dr. Julius Kühn, of Halle, in 1879 at an Agricultural Show in Berlin. He there exhibited Kurdiuk rams which in their second year had large fat rumps, although they had neither been reared in their native country nor on their mothers' milk. When the mothers were taken from the salt steppes they were found to be mangy all over, and the lambs on birth were immediately removed and raised apart.

Good fur-producing Karakuls are found only in very limited numbers and on certain ranches owned by Bokhara noblemen, who, however, do not even make an attempt to prevent in-breeding or to secure the elimination from the breeding stock of Afghan blood, which is indicated by the fine downy wool underneath the hairy fleeces. The result is that good sheep and good lamb-furs are steadily decreasing in numbers and are believed to be within measurable distance of extinction. Although the body may be free from any trace of down, evidences of an ancestral dash of the soft-wool breeds may be detected on the tail or about the back of the head in the region of the ears and the belly.

The late Emir, who died in 1911, had extensive flocks in different parts of his kingdom, and took a keen interest in his sheep, from which he derived a substantial part of his income. He travelled with the yearly products, lamb-skins, wool and hides, under the care of a special minister, to the fair at Nizhni Novgorod, and netted during his last year nearly 2,000,000 roubles. He was an excellent merchant, but no breeder; and he took no interest or care in preventing in-breeding or keeping out the obnoxious Afghan strain of blood. It is possible that he did not even know the fundamental importance of the practices referred to.

Common sheep, often of very inferior quality, are also raised in sections of Bokhara. The country east of Persia and North of Afghanistan is a large tract of land only fit for sheep-raising. Round the cities of Kerki, Karshi, Burdalick, Kara-Kul, Djenan, Karnichi, Puloti, Sharshaus, and Khiva, large numbers of Arabi (of Danadar-cross origin) and fat-rump sheep are kept. Their value in the fur market stands in about the same order as that in which the cities are named, and depends upon the amount of Danadar blood which has been infused into the common "grade" sheep of the country.

In Bokhara, also across the mountains into Persia, one finds the "Shiras" or half Persians, named from the town of Shiras. The question of quality there depends on whether a good or a bad ram had been got from Bokhara, and whether he had been bred to coarse-wool, fat-rump, or soft-wool Afghan ewes.

The limit of production has long ago been reached in Bokhara. The figures showing the quantities of skins collected there annually vary somewhat round about 1,500,000 "Persian Lambs" and 100,000 "Broad-tails."

The actual figures for 1911 and 1912 are instructive:—

"Persian Lamb" skins collected in			1911	...	1,500,000
,,	,,	,,	1912	...	1,814,000
"Broad-tail"	,,	,,	1911	...	100.000
,,	,,	,,	1912	...	35,000

The increase of 314,000 "Persian Lamb" and the decrease of two-thirds of the usual number of "Broad-tails" collected were due to favourable climatic influence.

The average annual value of this export trade has been estimated at approximately £1,000,000.

Colonization of the Karakul Breed.

It was at one time asserted that only on the steppes of Asia would the Karakul sheep retain the curly character of its coat, and that on land where the ewes wander outside the natural districts the characteristics were gradually lost with the second, third, and fourth lambs; and it was therefore considered doubtful if the valuable qualities of the fur could be maintained in the case of lambs bred in Europe and America. This opinion was probably the result of imperfect observation, as Asia contains many sheep which do not possess the characteristics peculiar to the Karakul and which may have provided the sires of later lambs.

There are instances on record of more or less successful breeding of Karakul sheep for their lamb-fur in all the great Continents. About fifteen years ago Dr. J. V. Sinitzen, the greatest Russian authority on Karakuls, imported the first flock of them into the Crimea, and they have done well. Councillor Paul Thorer, senior partner of Theodore Thorer, one of the largest and oldest of the fur merchants of Leipzig, was one of the first professional experts to follow him and visit Bucharest, which he did in 1902. On his return Thorer enlisted the interest of King Frederic of Saxony and lectured on the possible advantage of the propagation of Karakul sheep in German colonies. The idea was taken up by the Director of the Agricultural Institute at Halle, his Excellency Privy Councillor Kühn. In 1903 four rams and twenty-six ewes of what were believed to be pure Karakuls were secured from Bokhara and sent to Kühn's farm at Lindchen in the Mark of Brandenburg, while two years later another small lot was obtained. Experiments proved that "at least no deterioration in quality could be shown to exist in the lambs born of the original imported sheep." The common opinion that the Karakul lamb suitable for the fur trade could only be produced in its native country was thus rather severely shaken. Some German landowners subsequently made an attempt to breed Karakuls for fur, but the high cost of feeding is a serious drawback to development. It is, moreover, to be feared that the sheep imported had not been selected with a view to the complete exclusion of fine wool, for Dr. C. C. Young reported in 1912 that he "examined sixty ewes descending from Thorer's flock and only found three of them void of the fatal down-like 'underwool.'"

Karakul sheep were also introduced to the sandy districts of the northern plains with the intention of increasing the value of the poorer parts of Germany. The Rhoen sheep gave the best results, but not till the seventh top-cross of pure Karakul ram. Success there has not been so great as in German South-West Africa and in other places abroad. At least one shipment of thirty ewes and a ram intended for German South-West Africa was cancelled on account of the animals being affected with bronchial worms, deadly enemies of sheep, and suffering from malnutrition, from climatic and other causes.

In order to introduce the sheep to the Trans-Caspian districts the Russian Department of Agriculture established twelve years ago a State sheep farm near Aschabad, picked ewes and rams being brought from Bokhara. The wrong type of sheep seems to have been procured, as Dr. Young, after examining some 1,500 so-called Karakuls on this station, reports that he "did not find one fur-producing sheep!" (he meant, of course, of good Karakul quality and free from fine wool) "all being Arabi-Afghans." A number of stud rams and ewes are nevertheless sold annually to the inhabitants of the surrounding country as well as to other breeders.

Batches of Karakul sheep have been drafted into the Kuban district towards the north-west of the Russian Province of the Caucasus, bordering on the sea of Azov. The constitution of the pure breed, which in comparison with local breeds have been there dubbed "delicate animals," has been fortified in some districts by crossing with the local breeds. This is quite in accordance with sound commercial practice in other parts of the world on introducing a breed of sheep, especially if it be an improved breed, to conditions which markedly vary from those of its habitat. Breeding is reported to be most profitable. In this instance soft-wool sheep must have been more or less rigidly rejected. Dr. Young reports that each ewe produces one or two lambs, the skins of which fetch, according to quality, from 10 to 20 roubles, and in the case of good skins 30 roubles. According to the Poltava Agricultural Society's prices, ordinary breeding Karakul sheep sell at from 60 to 80 roubles, but those known to give specially good results cost from five to ten times as much. The rich milk of the ewes relieved of the duty of rearing their lambs is made, during a period of four months or more, into butter and cheese. Broad-tails are known to be much better milkers than fat-rumps.

Many farmers in the Crimea and North Caucasus have introduced Karakul rams, and in 1909 the Roumanian Government bought a number to encourage the farmers to begin the breeding of lamb-fur, but unfortunately most of the animals were Arabi-Afghans, and only those that had little or no fine wool on them gave the desired results. The Karakul-Duzbai ram alone produces a useful cross; that by the Karakul ewe and a ram of another breed is inferior.

Dr. Young throws valuable light on the position of the trade in the distribution of rams and of their prices and quality, in a report on the sale of ninety Karakul rams among other Asiatic sheep, which took place at Moscow in October, 1912. Many were sold at 80 to 300 and 600 roubles each, although the best tight-curl producers were few. In the great majority of cases there was evidence of a strain of the white fine-woolled Afghan, a type of wool that seriously injures the formation and the tightness of the curl as well as its lustre, which implies an open-curled lamb skin at the unsatisfactory price of 12s. 6d. to 16s. 6d., in place of £2 for good skins. The impurity of blood was indicated by the soft wool on the head, neck, abdomen and body, and even on the lower extremities of the limbs, which in the true fur-producing sheep are always covered with very lustrous, jet-black, stiff hair, similar to the hair of the face and ears. There were only about ten of the best fur-producing sheep in the consignment. Dr. Young bought two Karakul-Duzbais at a high price, as well as a four-horned Karachaev buck and one monster Kalmic or fawn fat-rump, the nearest representatives of the original wild *Ovis steatopyga* (if such ever existed).

A broad-tail Voloshskaya hybrid, which strongly resembles the Lincoln ewe, was rejected (though said to be almost as heavy as a llama) because experts like Sinitzen stated it would not breed true to type—a dictum now questioned by Young and eminent Russian breeders.

The most extensive venture in introducing Karakul sheep to a distant country was made in January, 1909, when 252 ewes and 22 rams were shipped to German South-West Africa from Bokhara. They had been selected with the greatest care through the agent of the Thorers in Bokhara from the best flocks in the country. On the long and tedious journey by road and rail only one died and one was lost. Within a few months of landing the greater part of them were reported to have succumbed to blue-tongue and catarrhal fever. Of the few that were saved the lambs did well, and it is now understood that the industry is an established success, and that the sheep have found climatic conditions on the higher plateaux of German Damara Land and Namaqua Land, which are not far removed in certain particulars from those of their original habitat. Private breeders are able to purchase rams from the Government flock, and the fat-tailed hairy Africander breed of South Africa is an excellent foundation stock on which to build.

(Since this paper was read it has transpired that a very severe controversy is going on in German South-West Africa as to the lines in sheep breeding which are likely to prove best suited to the country. "The point at issue is whether the Africander fat-tailed sheep which forms the bulk of the ovine population—the proportion being 500,000 against 50,000—should be crossed with Merino rams or with Karakul rams. The people interested in the wool trade prefer the Merino, but the Government and the farmers are anxious to grade up *all* the black and white fat-tails and their progeny with the Asiatic breed." The lambs are slaughtered at a week old, provided the skinlets are good enough, and "they think they can, in this manner, make any amount of money and keep down overstocking of the farms." The price goes up to £2 each, or more in rare instances, but it is believed the industry would pay if from 10s. to 15s. could be realized for the skins. The question will resolve itself largely into one of climate. If the country proves to be one suitable for the Merino graded up from a fat-tail ewe foundation, no doubt the wool sheep will ultimately claim a share at least in its progressive development.)

In 1911 the Emperor of Austria, in whose southern dominions Karakul breeding is reported to be a growing and successful industry, presented to Dr. Roque, Saenz Peña, President of the Argentine Republic, a flock of about twenty Karakul sheep. They were sent to an estancia among the hills of Tandil in the Sierras of the South of the Province of Buenos Aires, where they are undergoing acclimatization before being distributed to other sections of the country. So many breeds of sheep do well in that country, where there is great variety of soil and climate, that success may be confidently expected for this latest addition to their number.[10] There will be a wide scope for crossing experiments between the Argentine Criollo, a thin, somewhat curly-coated inferior but hardy breed, and the various well-established breeds of British long-wools, including Lincolns.

Perhaps the most remarkable, if not the largest, colonization of the Karakul breed was effected in Texas by Dr. C. C. Young, who was born in the Province of Bessarabia in Southern Russia, where his father and grandfather bred fur-bearing sheep Tshushka, which strongly resemble the Black Danadars, and where he early developed a fascination for the breed and gained invaluable experience of them. In 1908 he introduced fifteen pure-bred Karakuls; about 8 guineas per head being paid for ten ewes, and 10 guineas each for five rams; only one ram, however, bred true to type and produced good skins. The estimated cost, with travelling and other expenses included, was not far short of 200 guineas per head before they finally reached their destination. The time occupied was fourteen months, and included nine months' quarantine, first in Russia and finally at the Federal Quarantine Station in New Jersey, to avoid the dreaded danger of introducing surra, or some other little understood Asiatic disease. Although sheep do not contract surra in such a manner as to die from it, it is believed that they carry the surra micro-organism, *Trypanosoma evansi*, in their blood and, by the medium

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[10] This statement is questioned by Young, who pronounces them to be *all* Karakul-Afghans.

of blood-sucking flies, are able to transmit it to other live-stock which, like horses and camels, die or alternately again pass it on, after the manner of the sheep, to other animals.

No trace of any disease was found, nor was it likely to be in sheep from such a healthy country as Bokhara, where surra does not exist. The wonderful hardiness of the breed, as compared with other large long-wool breeds, was demonstrated by the fact that through the trying ordeal of the long and tedious journey, including incarceration for over three months in a dark barn, none of the original animals or any of the seven lambs born at New Jersey, making a total of twenty-two, died on the way. They were put on board at the port of Libau late in October and arrived in New York early in November. Darkness was believed to be necessary to test for the presence of surra.

Until comparatively recent years it was practically impossible to get any Karakul sheep out of the country, and even now "the Authorities of Bokhara put every obstacle in the way of foreigners attempting to export the valuable animals." To make the position still more difficult, the Emir has recently issued an edict absolutely forbidding the exportation of Karakul sheep, and none is supposed to have left the country except those obtained by the various agricultural societies of European Russia.

Owing to these difficulties, and the fact that the Bokharan traders will, if possible, provide Karakul-like cross-bred animals in place of the pure-bred sheep that would breed true, it is an extremely uncertain undertaking to secure the genuine Karakul sheep even for those willing to pay a good price. Dr. Young got his sheep by means of letters of introduction to the Russian Government from ex-President Roosevelt and Secretary Root, but only with the greatest difficulty. By this means he enlisted the sympathy and secured the help of His Excellency A. S. Yermoloff, ex-Minister of Agriculture, and later Member of the Imperial Council, as well as of the Poltava Agricultural Society, assisted by Michael Alekseevitch Stamatoff, who personally supervised the selection of pure-bred sheep from the best flocks. [From Stamatoff's description of the breed, translated by Dr. Young, much valuable information has been borrowed for this paper. We have also to acknowledge indebtedness to Ernest Poland (of P. R. Poland and Son, London), to the English translation of the excellent monograph, "300 Years Thorer Family, 50 Years Theodor Thorer," by the present head of the house, Paul Albert Thorer, Royal Saxon Councillor of Commerce, and also to Dr. Young himself, who in 1909 inspired us with an interest in the subject which has never flagged, and who was again in Bokhara in 1912, 1913, and 1914.]

In 1911 Dr. Young's flock had increased to fifty-six in number, and eventually the Karakul Sheep Company was formed to take them over. Pure-bred Karakul rams were bred to a number of high-grade long-wools, including Lincolns and Cotswolds, as well as close-woolled Merinos and Downs. The long-wool results proved so satisfactory, and especially the Lincoln cross, that 1,000 high-grade Lincoln ewes were secured and bred to Karakul rams in 1912. A second importation, consisting of eleven rams and six ewes, arrived in quarantine at Baltimore in March, 1913; one valuable ram died in quarantine, which left rams of only seven unrelated high-class blood lines in America. Five of the rams were bred to 400 Lincoln, Highland Blackface, Leicester, and other long-wool ewes, including a few Karakul ewes, but the results of these tests have not been made public.[11]

Owing to the interest taken at the time, 1911, by ex-President Taft and ex-Secretary James Wilson in the new American industry, the United States Bureau of Animal Industry conducted experiments by crossing a selected Karakul ram with ewes of the Barbado breed (a cross from the Barbary).

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[11] Since the foregoing was written Dr. Young succeeded in getting out in the end of July, 1914, another specially selected lot of about the same number as the first lot of sheep exported, in spite of the existing embargo upon foreigners entering the military zone of Bokhara. They left Libau by the last steamer for New York before the outbreak of War, but six rams were lost through an outbreak of fire in the quarantine station in the spring of 1915.

The Barbado second cross was entirely satisfactory, and a beautifully smooth, figured, rich, velvet-black skin was produced.

Dr. Young obtained excellent results from breeding Karakul rams to high-grade, fawn-coloured, Persian fat-rump ewes that were imported into the United States a little earlier than his own sheep and were free from fine wool.

The Young Karakul Sheep Co., Ltd., Charlottetown, P.E.I., Canada, has had some promising results by breeding with Scotch black-face ewes, but the humid climate is a hindrance to progress.

There is a Mexican hairy sheep which would give excellent results, as it has stiff hair instead of wool, but most of them have been spoiled by Merino blood.

Kelf-blood Karakul-Merinos and Karakul-Shropshires were worthless. Young crossed some of his Karakul-Afghan rams, sold to him as good Karakuls, with some Lincolns, but got much inferior skins than from *coarse-wool Karakuls*. The best of the latter's progeny were sold under the name of "Persians"; and Henry Basch, of the Dyeing Works of New York, and Speer of Thorers, priced some skins as high as £2 10s., and reported so to the Society of Agriculture in Washington.

Experiments in Scotland.

An interesting experiment was initiated under the auspices of the Edinburgh and East of Scotland College of Agriculture and Board of Agriculture for Scotland, when a Karakul-Duzbai ram was bought for £100 in the autumn of 1913, through Dr. Young, from what he pronounced to be the best flock of fur-producing Karakuls in European Russia.

In characteristic breed points the ram conformed closely to what is looked for in a Karakul ram of high breeding, with the exception that he had scurs in place of horns, and that slight traces of fine under-wool were to be found, especially near the root of the tail and about the ears. He was mated, though a little late in the season, to thirty-seven selected pure-bred ewes belonging to seven British breeds—Scotch Blackface, Border Leicester, Romney Marsh, Herdwick, Cotswold, Dartmoor, and Cheviot. The tup worked well and got forty lambs—all without exception black and curly, though the curls differed in degree of tightness. The lambs showed pronounced Karakul characteristics, including, with one exception, drooping ears and a rudimentary fatty enlargement near the base of a long tail. In two cases only the tail had a white tip, which was correlated with a white spot on the forehead.

The lustrous, tightly-curled fur, which the best of Dr. Young's rams produced in the first generation, did not appear; but the ewe lambs, with a single exception, have been kept. Within four or five generations of sheep it should be possible to produce a high-grade Karakul-Duzbai even superior to the original pure breed, and to develop rams, made "pure by crossing" by the use of pure-bred sires, that would breed true to type and be of even higher quality and of greater value than the sheep which can be bought in the market at present.

Conclusion.

Unqualified success in fur breeding, although now believed to be certain, is coming more slowly than might be anticipated. The prospects of establishing a new meat industry in this country are, however, most encouraging. The carcasses of the ram lambs, which weigh from 8 lb. to 10 lb. each when 75 to 80 hours old, have proved to be a rare delicacy, which would doubtless soon become appreciated. There is no reason why Karakul "baby-lamb" should not be received with the favour attending "baby-beef," and command the remunerative price of 3s. per lb., thus providing a solid basis on which a British Karakul lamb-fur industry might be reared.

The interest of the scientific world is so new in connection with this industry, and there is such a wide gap between the fur-breeder in Asia and the fur merchant and fur wearer in Europe and America, that much uncertainty prevails as to the origin and history of the best fur-bearing sheep and the most successful way to conserve and develop them. Opinions are only now being formed, and reliable information is slowly taking the place of what was mere conjecture or romance. The subject is not only of value from the scientific point of view, but there is great scope for the development of its commercial as well as its æsthetic aspects, and there are sufficient guarantees that the business of sheep-fur production, now in its infancy, is likely to expand to almost indefinite proportions.

THE UTILIZATION OF SUN POWER FOR IRRIGATION AND OTHER PURPOSES IN TROPICAL AGRICULTURE.

By Frank Shuman.

It is well known that in order to obtain the best results from agriculture in most parts of the tropics, irrigation is necessary, and also that in many parts of the tropics coal or other fuel for doing this irrigation with mechanical power is very expensive. My present purpose is to show how the unlimited power of the tropical sun can be utilized for irrigation and other purposes, and there is surely nothing in the tropics cheaper and more plentiful than sunlight.

The rays of the sun seem at first sight to be intangible and impossible to control in such a way as to utilize them for practical purposes. This is not the case however. They can be caught on mirrors, thrown in any desired direction, absorbed and turned into useful heat by means of proper contrivances.

If the tip of an ordinary tin funnel is sawed off, the inside polished, and the funnel turned towards the sun, the sun's rays will be caught by this funnel and will pour through the hole at the bottom just as water would, and if a small blackened boiler were placed at this opening they would impinge upon this, be absorbed and turned into heat, which heat will turn the water in the boiler into steam, and this steam would give power. This illustrates in a homely way the broad principle underlying all sun-power plants. If this interesting little experiment be tried it will be found impossible to hold one's hand over the hole where the caught sunlight streams through, because the temperature there will be considerably hotter than that of boiling water.

If a flat tin pan be painted dull black on the inside, covered with cotton around the bottom and sides to prevent loss of heat, and a thin layer of water poured in, covered with a pane of window glass and exposed to the tropical sun, this water will soon commence to boil and give off steam. It is not generally known that the tropical sun, without any concentration, can boil water and make steam, but such is the case.

The sun throws only light rays to the earth, and unless these light rays are absorbed no heat is produced. The rays first pass through the air and some of them are absorbed by the air and heat it to this extent. However, about two-thirds pass through and strike the earth, and here, again, they are absorbed to a varying extent according to the colour and nature of the surface they strike. When they strike water, most of them are reflected back into space. When they strike the sands of the desert also most of them are reflected away. And even when they strike the green of the forests great losses by reflection occur. This loss by reflection may be seen by looking at the moon. The sun shines on the moon, the moon reflects again most of the light, and a portion of it reaches us as moonlight.

Now, however, when the sun's rays strike a black surface they are all absorbed and turned into heat. Were the moon painted black, then we should not be able to see it at all. Were the whole earth painted black, all of the rays would be absorbed and turned into heat, and before evening a temperature high enough to melt steel would be reached and all life destroyed.

We have seen that we can collect the rays of the sun and can absorb them and turn them into heat. Now it remains to show how this can be done so as to get direct power in large quantities.

The sun shining into the black pan we have mentioned above will produce a temperature of about 250° F., and about four British thermal units of heat per minute per square foot of surface exposed can be created in this manner. But if we catch another square foot of sunlight on a mirror and throw this also into the black pan, then we can produce eight British thermal units of heat per minute and get a much higher temperature, and so on for every additional square foot of sunlight we throw into the pan we get an additional four British thermal units and a correspondingly higher temperature. This explains what is meant by "concentrating sunlight." If we keep on throwing in light rays in this way we would finally reach temperatures which would melt steel and even the hardest metals. This is not merely a theory; steel has been melted with concentrated sun rays, and a sixpence has been melted in 7½ seconds. Sunlight can be concentrated by lenses, but this would cost too much for power purposes. The concentration of sunlight by means of funnel-shaped reflectors also presents practical difficulties which make this method too costly.

In order to generate steam very high concentrations are unnecessary, and therefore we use in our Egyptian sun-power plant only five concentrations by means of mirrors.

After seven years of patient experimental work and the expenditure of very large sums of money we have finally solved the problem of producing mechanical power from the sun's rays, and have erected a 50-h.p. sun-power plant at Maadi, a suburb of Cairo, in Egypt. Cairo is 30° North, and is by no means the best place to put up a sun-power plant; but it is easily accessible, and as we wanted to exhibit our sun-power plant to the world we erected it there rather than in (we will say) the Sudan, where few people would go to see it.

All our figures and remarks are based on the actual performance of this plant, and as we know it would do even better work further south, we can consider our figures very conservative.

Unless sun-power can be utilized profitably there is, of course, no incentive to spend money and work upon it. Therefore the question of pounds, shillings and pence is an all-important one. As our fuel costs absolutely nothing, the question of mechanical efficiency does not enter into the matter. It is a question altogether of the cost of the construction, upkeep, and labour. If the cost of construction of the sun-power plant is so high that the interest on the extra investment (above the cost of a steam plant of equal capacity) will be so great that it cannot compete with coal even at a point where coal is very costly, then there will be no incentive to go further. If the sun-power plant cannot be so constructed that an ordinary engineer can run it and that its wear and tear will be reasonable, and further, that excessive labour will not be required to handle it, then also there is nothing in it.

These are important factors to consider. Therefore it is necessary for me to give definitely the cost of construction, maintenance, and labour, and to show definitely that sun-power can be properly produced throughout those vast areas of the inland tropics where coal is very expensive.

Sun-power plants need not compete with coal for the present at any of those tropical places near the coast where coal is reasonably cheap. At present we can confine our work to where the sun is at its best, and where coal is very expensive, from, say, £2 to £3 a ton. These prices of coal obtain throughout very large areas in the inland tropics—areas which, given plenty of mechanical power for irrigation, can be made to support large populations. Finally, when coal and oil are used up we shall all have to come to sun power, but by that time we shall know much that we do not know now, and will particularly know how to transport "sun power" from the tropics to the temperate zones.

The value of our work consists in generating steam for power purposes with the heat obtained by the sun's rays. "Sun steam" is exactly the same thing as steam generated by burning coal under a boiler, and can be used for any desired purpose and in any desired manner in which ordinary steam can be used. It can be used for driving reciprocating engines or turbines, for irrigation, or for the running of factories. In fact, for anything whatever where power is required. It is, therefore, not necessary to describe except in a general way the engine and pump end of this sun-power plant. The engine is a low-pressure reciprocating condensing engine, and the pump an ordinary reciprocating pump, which, in this instance, was used for pumping water out of the Nile as an exhibition of its power.

Experience has shown us that steam at atmospheric pressure (14·7 lb. absolute) gives the greatest return in power per pound sterling invested. If we attempt to generate high-pressure steam we can easily do this by means of the sun's rays, even up to 500 lb. to the square inch. This, of course, would give us very high engine efficiencies; but, on the other hand, we would lose much more than we gained because, on account of the higher temperatures of the boilers, the loss by conduction and convection into the atmosphere would greatly increase. Also the cost of constructing the boilers owing to the strength of metal required would greatly increase, and, as stated before, the cost per foot-pound of energy produced is the deciding factor.

The steam is generated in the sun-heat absorbers, five in number (each 13 ft. wide at the top and 204 ft. long), which are parabolic troughs for catching the sun's rays and throwing them upon the boilers swung at the focal line.

Each mirror is set at such an angle in relation to the sun and the boiler that all the sun's rays falling on the mirrors are thrown on to the boiler. This boiler being painted a dull black absorbs these rays and turns them into heat, which generates the low-pressure steam referred to.

The heat absorbers are placed about 25 ft. apart, so that they will not shade each other when the sun is low in the morning and afternoon. Their axes point north and south, and they turn from east to west on their axes to face the sun.

The mirrors are set in a light steel framework, each one at the proper angle to throw the light upon the boiler, and consist of ordinary sheets of third quality thin window glass silvered on the back, and the silvering protected by proper means from the atmosphere.

At the focal line of all the light rays there hangs in the present plant a cast-iron boiler, which is tubular at the top and flat at the bottom where the water space is. This boiler is 15 in. high, and is hung on light rods in such a manner that expansion and contraction will not interfere with it.

These heat absorbers are set on crescents which roll in a system of small racks and pinions for turning the sun heat absorbers from a low eastern aspect in the morning to a low western aspect in the evening.

The heat absorbers are turned by the engine and their speed of turning is regulated by an adaptation of the thermostat which throws a friction clutch in and out. The thermostat is located right under the boiler. As long as the thermostat is in the shade this means that the heater is pointing directly at the sun. When the sun moves ahead a little then the edge of the sunlight strikes the thermostat. It bends and immediately throws the small friction clutch into place, and then all the heat absorbers turn westerly a fraction of an inch or so. As soon as the thermostat is again in the shade the clutch is released and the sun heat absorbers stand still.

In this way, by short intermittances, the heat absorbers are always kept facing the sun throughout its course during the entire day.

The thermostat acts very satisfactorily indeed, and it is interesting to see these large heat absorbers turning apparently by their own volition steadily with the sun as many plants and flowers do.

The framework of the heat absorbers has been designed in such a manner that by special machinery they can be manufactured very cheaply. There are only eighteen different kinds of pieces in the entire framework and each piece is very simple. They can each be punched out at one operation in a second.

As the question of transportation to outlying tropical districts is an important one, care has been taken that all the pieces are light in weight; no piece weighs more than 30 lb.

The heat absorbers at Cairo were erected entirely by native labour under the supervision of one American engineer in eleven days.

Sun-power plants can be built of any size, from 5 h.p. up to 10,000 h.p. if required.

The heat absorbers at Cairo started to make steam in midsummer about 7.30 o'clock in the morning, and kept at work until 5.30 in the evening.

Tests of the steam-producing capacity of these heaters, made by Mr. A. S. E. Ackermann, of London, show that the average production was 1,100 lb. per hour of 15 lb. absolute steam for a ten-hour day, and this is equal to an average of 50 b.h.p. This same plant, if set up 1,000 miles further south would probably give 65 b.h.p.

The steam produced was practically at atmospheric pressure, although the engine would work well with steam at considerably lower pressures. For instance, if a cloud passes over the sun for, say, ten minutes, then the engine draws on the reserve of steam held in the boiling water contained in the boiler, and will lower the pressure down to 4 lb. absolute before it would come to a stop. Early in the morning and late in the afternoon the engine also runs at pressures below the atmosphere, giving a corresponding amount of power.

The boilers of the present plant are surrounded by a single thickness of thin window-glass for the purpose of cutting down the losses by conduction and convection, particularly when the wind is blowing strongly.

The heaters are so constructed that they will stand a wind pressure of 30 lb. to the square foot safely. This means that they are entirely proof against any of the ordinary gales which may obtain in the tropics.

All the mirrors and glasses used in the construction of these heat absorbers are held in place by means of small brass springs in a very flexible manner, which prevents breakage due to expansion and contraction, and also means resilience to hail. In the regions where the sun-power plants are proposed, hailstorms are practically unknown, but at the same time this method of setting them means that they will stand considerably more hail than the ordinary hot-houses in which the glass is set rigidly.

It will, of course, be asked: What will be the effect of dust settling on the mirrors and on the glass? Any dust settling on the mirrors and the glass, of course, means loss of power, according to the thickness of the dust. Therefore we must keep our mirrors clean. Labour is very cheap in the tropics, and 20 pence a day to do this work would be sufficient to keep the mirrors entirely clean, the proper washing arrangements, of course, being provided.

Resolved to its first principles "sun-power" is a very simple proposition. Provide a boiler, throw plenty of sun's rays upon it, and generate your steam. To make sun-power collection pay, however, requires much thought in designing on the compromise lines so necessary to follow in a battleship design.

You may ask: What will our sun-power plant do when there is no sun? Of course, when the source of our supply of power is cut off we cannot get it; but we can do what is done in a great many other lines, and that is, store it in an already well-tried and simple manner. During the day we will heat large quantities of water to the boiling point and store this in large tanks, properly insulated from the atmosphere. From this boiling water we will draw during the night or during a rainy day low-pressure steam, and with this run our engine, which is so constructed that it will run economically at 4 lb. absolute. In other words, as the condenser draws on the boiling water in the tank through the engine the heat contained in the boiling water will generate low-pressure steam, and this steam will run the engine. There is nothing new in the art of using low-pressure steam generated from water which has been brought to the boiling-point by extraneous means. It is a very practical and successful method of storing power in the tropics, where this power is produced from a source which is entirely free of all cost.

It will occur to you that sun-power plants occupy an enormous amount of room per horse-power. This is quite true; but in the locations where we are suggesting their use land is very cheap indeed, and the amount of room occupied is not a great disadvantage.

Sun-power collecting may be called "power farming," and may be compared to growing coal. If coal to run a 50-h.p. engine perpetually could be grown without any expense whatever on an acre of adjacent ground, then this acre of ground would be exceedingly valuable in the tropics with coal prices at from £2 to £3 per ton. Hot-houses to produce equal net values would have to cover many times larger areas, and still hot-houses do pay even where land is very expensive.

The cost of upkeep is an important factor. The heat absorbers are made of reinforced concrete for the foundations, steel for the framework, cast-iron for the boilers, and glass for the mirrors and boiler covering—all materials which are practically indestructable in the tropics. If the steel framework is painted about every eighth year or so it will last for centuries. The foundations would last indefinitely, and the boilers should last a very long time. Experience has shown that the mirrors and glass do not break, owing to the method in which they are set. The only parts of the heat absorbers which wear out are the rollers and racks and bearings, and even these will last about ten years, and can then be easily renewed at little expense.

To convey an idea of the present possibilities of sun power I might mention that the sun heat absorbers at Cairo can generate steam for 50 h.p. for ten hours per day every day the sun shines. The steam-producing part of this plant will cost erected in the tropics, according to a careful estimate when constructed under proper manufacturing conditions by special machinery, the sum of £1,560, being at the rate of £31 per b.h.p.

The boiler, stack and buildings of a coal-burning plant to generate the same amount of power for ten hours per day throughout the year would cost £770. We now have the following comparisons:—

SUN-POWER STEAM GENERATING PLANT, WORKING 365 DAYS FOR 10 HOURS PER DAY.

	£	s.	d.
Interest on capital expenditure of £1,560 at 5 per cent. ...	78	0	0
Wear and tear depreciation at 5 per cent.	78	0	0
	£156	0	0

COAL-BURNING STEAM GENERATING PLANT, WORKING 365 DAYS FOR 10 HOURS PER DAY.

	£	s.	d.
Interest on capital expenditure of £770 at 5 per cent.... ...	38	10	0
Wear and tear depreciation at 5 per cent.	38	10	0
Coal consumption at 2 lb. of coal per B.H.P., 163 tons at 9s. 8½d. per ton	79	0	0
	£156	0	0

This shows that the sun-power plant can compete on even terms with a coal-burning plant which can obtain its coal at 9s. 8½d. per ton delivered to the furnace doors. Any excess in the cost of coal burned above this figure is clear profit in favour of the sun-power plant, and as the cost of coal in the more favourable places in the tropics where sun-power plants will be erected for the present may be taken at not less than £3 per ton, the saving will be as follows:—

Cost of working Coal-burning Steam Generating Plant as above.

	£	s.	d.			
Interest and wear and tear depreciation ...	77	0	0			
163 tons of coal at £3 per ton	489	0	0			
				£566	0	0
Sun-power steam producing plant per year				156	0	0
Saving ...				£410	0	0

This shows that with coal at £3 per ton there is a saving of £410 per annum (or nearly 52 per cent. on the extra cost, £790) on the sun-power plant over that of the coal-consuming plant, which would mean that in just over two years the saving in fuel effected by its use would wipe out the extra cost.

Now the above figures are based on ideal conditions, and we will not have these ideal conditions always in actual practice. For instance, when the sun is overcast with clouds, these clouds will interfere, but the margin is so great that I am quite sure that even at the present time sun-power plants will be very profitable in great areas in the tropics, and would enormously aid the development of interior countries.

There is a splendid field for sun-power plants in entirely new countries where railroads have not yet been laid down, where there are no rivers, and where fuel prices are therefore prohibitively high. Sun-power plants can be erected here, and large areas of fertile ground made cultivable by pumping water from underground.

Wherever reasonable gravity irrigation can be used, of course, we do not propose sun-power irrigation, but in many cases canals, even over 100 miles long, have been proposed for irrigation of new colonies, and the cost of these canals may run up into the millions.

After the canal is once built, of course, the colony would have its water free except for the cost of upkeep of the canal, but the interest on the huge investment would go on as an expense. Now in this case, if there is underground water, it would be much more profitable to build at the start just enough sun-power plants to supply the needs of the present small population, and then add every year more sun-power plants as the number of inhabitants increases.

An important advantage sun power has over coal power is the fact that if a farmer or a community has a sun-power plant they are absolutely independent. Strikes and blockades cannot stop it, and it is not necessary to carry a store of coal for contingencies. They are sure of their fuel being always delivered free on board of their plant and actually into their boilers.

All the figures have been based on what we have already done and the comparisons are made under present conditions. We will, however, learn how to build better and cheaper, because sun power is still very new. Every year coal and oil will become more expensive, and therefore as time goes by conditions will become better and better for sun power.

Everyone knows how the price of oil has risen already, and also that coal is rising, although much slower. We are using to-day twice as much mechanical power as we were using twenty years ago, and in twenty years from now we will be using again twice as much, and prices of coal and oil are bound to rise at a progressively greater rate.

The amount of power which can be secured from the sun is, of course, unlimited. If an area of 143 miles square at a favourable point in the tropics is planted with mirrors spaced as wide apart as in our Cairo plant, this area would furnish us with power and heat sufficient to meet the demand in the entire world to-day. And this area would be a mere dot on the desert of Sahara. The sun throws down to the earth in three days as much heat as would be produced by the combustion of our entire earthly store of coal and oil.

Sun power is most logical. We all know that the sun is the central power-house of our universe, and we must put ourselves in direct connection with this central power-house. The sun is some 93,000,000 miles away, but nevertheless its rays reach us in five minutes, and we can catch these rays and thrust them into our boilers, and this is the direct and shortest possible method of securing unlimited power.

ECONOMIC DEVELOPMENTS IN THE ANGLO-EGYPTIAN SUDAN.

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In the following remarks some familiarity must be assumed on the part of the reader with the main events in the recent history of the Sudan and with the principal physical features of the country. It may, however, be useful to recapitulate a few points, although they are probably well known, in order to throw into proper perspective some of the facts which this paper is designed to illustrate.

It is less than fifteen years since the vast stretch of territory, now known as the Anglo-Egyptian Sudan, was wrested from the rule of the Dervishes, who, by methods of barbarity unparalleled in modern times, had reduced it to misery and destitution.

At the time of the conquest the Sudan was almost *in articulo mortis.* Rest and quiet and careful nursing have restored it to convalescence, but few could have been found in 1898 to congratulate Great Britain and Egypt on their joint acquisition.

The population had been reduced by famine, warfare, and pestilence from some 8,000,000 to less than 2,000,000. The tribal organization had been deliberately wrecked. Trade and commerce were non-existent and industry was at a standstill.

The subsequent record of the Sudan exemplifies a truth which has been illustrated a thousand times in the history of mankind, that the destructive effect of the most devastating tyranny is comparatively short-lived. The primary means of production always survives a period of reaction and recovery inevitably occurs, and, as soon as the checks to development are removed, Nature reasserts herself and man returns to his normal avocations. The interesting feature in the recent life-history of the Sudan is the rapidity of this process of recuperation.

By means of a few remarks on this subject, namely, the speed of the recovery after the oppressive misfortunes of the past, some light may be thrown on the present state of economic affairs and the possible line of future developments.

All who have personal experience of work in the tropics will readily agree that it is useless to insist upon perfection of administrative method. It is necessary to take things as one finds them and allow a liberal margin for contingencies. Progress in Africa is not to be measured by European standards. Yet even on this lower plane results rarely justify self-complacency. There is generally ample room for wisdom after the event.

Subject to these reservations, the grounds on which some claim to efficiency of method in the Sudan may be founded are that the country has already become solvent, the financial support from Egypt, on which it has had to depend hitherto in order to balance the budget, having been dispensed with in 1913. The Sudan now pays its own way. The revenue has increased steadily year by year from £E.127,000 in 1899 to £E.1,644,000 in 1913.

External trade, of which there was practically none at the time of the conquest, approaches £E.4,000,000 per annum in value.

Law and order have been established throughout practically the whole of the great area of the country, and, finally, the British Government have recently testified to its confidence in the economic possibilities of the Sudan by guaranteeing the interest on a loan of £3,000,000 for cotton growing and other purposes.

If one glances suddenly from the picture of past misery to that of present prosperity this happy revolution in the fortunes of the country appears almost miraculous.

The change is, indeed, remarkable, but it must be remembered that the Sudan is a continent rather than a country, and possesses numerous and varied natural resources arising from the diversity of climate and soil which prevails over its million square miles of tropical territory.

These primary assets even the Dervishes could not destroy. In certain cases the desolation to which they reduced some parts of the country had the contrary effect. It is said, for instance, that the most accessible tracts of gum forest, which provide the principal export from the Sudan, owe their origin to the depopulation resulting from Dervish atrocities.

Secondly, although the Mahdi and the Khalifa destroyed most things in their path, there was little industrial capital of which they could make havoc. If an invader razed the mills of Lancashire to the ground, it is doubtful whether the cotton-spinning industry would ever recover from the shock and regain its lost pre-eminence.

In the Sudan, on the other hand, a primitive form of agriculture, needing only a few simple instruments, has always constituted the main occupation of nearly the whole of the settled population. Thus, under efficient Government, even the maximum period required to enable agriculture and other industries to recover was unlikely to exceed the time necessary for gaps in the population to be made good.

As it happens, it has not been necessary to await the consummation of that period, for although the population still numbers only about 3,000,000 the prosperity of the country is such as has never been known before.

The cause of this progress is that, under the present administration, the means of production in the hands of even the scattered remnant of population now existing have been rendered so effective that the results far surpass those obtained when the number of inhabitants was three times as great as it is now. By the method of simple equation one may arrive at some idea of possibilities under a full complement of population.

The Sudan has never yet enjoyed conditions which may be described as normal. A peculiar ill fate has perpetually dogged its course. The Dervishes, it is true, scourged the Sudan with scorpions, but it was already accustomed to the whip.

Sir Samuel Baker, in describing his travels in 1861, remarks that "the Provinces were utterly ruined and only governed by military force. The revenue was unequal to the expenditure, and the country paralysed by excessive taxation. Shut in by deserts, all communication with the outer world was most difficult, and the existing conditions rendered these countries so worthless to the State that the annexation could only be accounted for by the fruits of the slave trade." These remarks refer mainly to the Southern Sudan.

Colonel Stewart writing in 1883 paints a companion picture of the northern districts. "Many were reduced to destitution, others had to emigrate, and so much land went out of cultivation that in 1883 in the Province of Berber there were 1,442 abandoned water-wheels and in Dongola 613."

"Irregulars (Bashi Bazouks) were employed to collect the taxes. Many, if not most, of these men," he says, "are very indifferent characters: they are mostly swaggering bullies, robbing, plundering and ill-treating the people with impunity, and are a constant menace to public tranquillity.

The sores inflicted by these methods of barbarism are gradually being healed, but years must elapse before the hundreds of deserted villages are re-occupied, and the population suffices to cultivate the millions of acres of fertile land awaiting tillage.

There is thus no prosperous past or even any normal standard with which to compare the state of affairs to-day.

Roughly speaking the regeneration of the Sudan, so far as it has proceeded, may be divided into three periods.

The first of these may be styled the period of pacification, in that measures to provide security for life and property naturally took precedence over those of which the principal aim was economic development.

Although the situation still needs careful watching this first phase may be said to have ended some years ago.

It was followed by a period characterized mainly by progress made in railway construction, the effect of which was to place the Sudan on a completely different economic basis.

The railway programme is not yet completed, but the work done in the years 1906-10 nevertheless marks a distinct stage in the history of development.

Until the harbour and town of Port Sudan on the Red Sea were built and connected by railway with the interior, the Sudan was for all practical commercial purposes a land-locked country, debarred from foreign markets by the difficulty and expense of its only outlet to the sea via the Nile route to Egypt, a distance of some 1,400 miles over railways comprising three different gauges and divided from one another by some 200 miles of river transport.

In 1910 the railway was extended along the Blue Nile, and since then has been pushed on across the Gezira to El Obeid, nearly 1,000 miles from Port Sudan.

By means of its admirably equipped and well placed harbour, the greater part of the Sudan now possesses ready communication with Europe and the East. The registered tonnage of steamers entering and leaving Port Sudan in 1913 was 587,358 tons.

This change in the economic situation may be signified by stating that the country's economic interests have ceased to be local and have assumed an international character.

When the railway opening up the Eastern Sudan via Kassala, Gedaref, Mafaza and Sennar is built the main links in the chain of railway connection will have been forged.

The third period, which follows by a course of normal evolution upon those which preceded it, has just been entered upon. Its first stage is marked by the inception of the Gezira Canal project, whereby, in the fulness of time, some millions of acres of land in the plain lying between the White and Blue Niles may be brought under irrigation, mainly for purposes of cotton growing.

It is not easy to find a name to fit this third period of development without implying an undue differentiation from that which it succeeds. It may be styled the period of economic expansion, but it must not be inferred that it is only within the last two or three years that measures connoted by that term have received earnest attention.

The distinction between the two periods lies in the fact that it is only recently that the Sudan has acquired the capital and some of the other means necessary to accord some of the more important of these economic questions the treatment they deserve.

Hitherto the Sudan has had to make its living mainly by the sale of wild or semi-wild products, such as gum, ivory, livestock, dates, mother-of-pearl shell, ostrich feathers and the like, eked out by the small yield of an extremely primitive agricultural industry, and for some time to come, while the Gezira Canal project and other development schemes are maturing, reliance must still be placed upon this class of product.

In the near future, however, economic production should acquire a different aspect.

The expenditure of three millions on constructive economic work and the steady growth of a cotton-growing industry, which year by year will become of increasing importance to the world at large, must profoundly affect for the better every department of national life.

It will be apparent from subsequent remarks in this paper that the Sudan is far from being a "one-crop" country, but its hope, at any rate its larger hope, lies in the success of cotton growing. Now that the Gezira Irrigation scheme has been begun the Sudan has come to grips with the central problem of its career.

Predictions as to the possibilities of cotton growing in the Sudan, some of which are now beginning to come true, have been made for many years past. They rest on a good historical basis.

As long as 200 years ago the Sudan had a reputation both for its raw cotton, which was exported in some quantity to Abyssinia, and also for its cotton homespun, which was well known throughout North Africa.

Cotton growing is not, therefore, an alien industry. In certain districts the people have always shown both willingness and ability to grow cotton when suitable opportunities have been within their reach.

Until quite recently the best chance afforded them of carrying on this industry with success has been in the Tokar district of Red Sea Province. Here a torrential stream, the Baraka, flowing from the Abyssinian hills, fertilizes annually with its silt a portion of the large delta of land which it has formed near the town of Tokar. Some 40,000 acres of this alluvial area are planted annually with cotton, and the bulk of the yield, which has been gradually improved to a high quality under the supervision exercised by the Government, is equal to or better than "Fully Good Fair" Egyptian, notwithstanding the rude methods of agriculture still employed and uncertainty as to the direction which the flood will take.

At Tayiba, near Wad Medani on the Blue Nile, in the Gezira, about 110 miles south of Khartoum, a "demonstration" area was put under cultivation three years ago, in order to prove the possibility of growing cotton under conditions representative of those which will prevail under the Gezira irrigation scheme.

Native tenants at Tayiba have taken most readily to the up-to-date methods of agriculture demanded of them, and remarkable yields of cotton grown as a commercial crop have been obtained. In the first year the average yield per acre over 250 acres exceeded 1,560 lb. of seed-cotton, and in the second year the average yield over 610 acres was 1,786 lb. seed-cotton per acre. Excellent crops are now maturing in the present or third season of cultivation.

The aptitude displayed by the native tenant farmer at Tayiba is not surprising, since every year, when the rainfall in the Gezira has been adequate, the people on their own initiative have grown considerable quantities of cotton as a rain crop.

As far as cotton growing is concerned, the gradual exploitation of the millions of acres in the Gezira and of one or two other promising fields, such as the Tokar and Kassala districts, will provide full scope for the cultivating capacity of the Sudan for years to come.

The development of cotton land in other parts of the country, also to be reckoned in millions of acres, can be left to a future generation.

The Gezira scheme gives partial effect to an idea which has always been present in the mind of those occupied with agricultural policy in the Sudan, viz., to afford some protection to the cultivator against adversities which from time to time befall him owing to the vicissitudes of a comparatively small and variable rainfall.

For 1,000 miles south of Khartoum nearly all cultivation is dependent on the rains. Their intensity increases the nearer one approaches the Equator, but they are nowhere reliable. At Khartoum the annual rainfall amounts to about 6 inches; in the extreme south, to some 45 inches; but in the Gezira tract and throughout the Central Sudan, cultivation is subject to local and periodical droughts, and the husbandman's toil is not unfrequently wasted, though in good seasons he obtains ample crops to tide him over ordinary periods of scarcity.

Under such erratic conditions efficient and painstaking labour is hardly to be expected, and undoubtedly these recurring disappointments are largely responsible for a type of cultivator who is easily discouraged and, to the European eye, fatalistic and shortsighted.

The Gezira Canal scheme will turn the flank of this widespread climatic difficulty. It will afford the native security as to the requisites of production over a definite area, gradually increasing within a measurable period up to some half a million acres. It is confidently anticipated that the scattered population of the Gezira and adjoining districts will rally upon this delectable land, and will abandon the hazardous production of rain-grown crops for the assured results obtainable under irrigation. A relatively small area of intensive cultivation will be substituted for sporadic efforts spread over wide districts.

An erroneous impression possibly still exists as to the sufficiency of the labour supply in the Sudan.

It is true that in relation to the total area of cultivable land the quantity of available labour is lamentably deficient, but this state of affairs does not imply that there will be any dearth of cultivators for the Gezira irrigation scheme.

It has been estimated that for the completed scheme of 500,000 acres, which, of course, will only gradually be brought under cultivation, a cultivating population of 80,000 men and 40,000 women and boys will be needed. In the Gezira, north of the railway, there is already a resident population of 79,647 men, 98,369 women and 77,813 children. If to these is added the resident population of the Gezira south of the railway and of the adjacent districts, the total amounts to 179,724 men, 222,754 women and 204,242 children.

These numbers offer an ample labour supply on which to draw, especially as they take no account of the future drift of population into the Gezira from the rest of the Sudan and from beyond its borders.

There are also certain peculiarities in the circumstances affecting the growth of the population in the Sudan which have an important economic bearing.

Very few children survived the horrors of the Mahdia, and many men in the prime of life perished in the wars of that time. There is thus a curious dearth of young persons of marriageable age in the population of to-day, and this deficiency will not be made good until the numerous children born during the last fifteen years have reached maturity and have married.

Consequently, during the next twenty years the ratio of increase in the population should greatly exceed even that recorded since the conquest.

So much for the labour problem in its numerical aspect. There remains the question of quality.

A brief reference has already been made to this side of the question, but there are one or two other points of interest connected with it. They may possibly suggest a parallel to some of those who have been engaged in work elsewhere in the tropics.

It seems open to question whether criticisms of the inefficiency of tropical labour are always entirely justified. Certainly, in the Sudan, the Arab or semi-Arab cultivator has frequently belied the more than indifferent reputation with which he was accredited in the early days, and this fact naturally gives rise to the reflection that possibly the lethargy, improvidence and slipshod temperament, of which we so often hear, may be due, in many cases, rather to lack of opportunity or to absence of incentive than to sheer incapacity. It is easy to see that the results of ignorance and of that tendency to drift which proceeds from the lack of a definite point of view may be confused, for instance, with those of physical laziness. These moral disqualifications are naturally less difficult to deal with than a deep-seated fatalism which springs from perverted religious conceptions, but even as regards religious fatalism it is arguable that this attitude of mind is not intuitive but the accummulated effect of experience and environment.

The constant disillusionment which follows upon the practice of inefficient methods of production, in circumstances that have involved risk to life and property since time immemorial, must necessarily produce a fatalistic type of mind, and it does not seem too much to infer that the substitution of practice based upon scientifically ascertained facts must in time act as a mental and moral corrective, for the simple reason that it will probably give the labourer satisfactory results, whereas his old rule-of-thumb regime frequently failed to do so.

Possibly a new period is beginning in which the cultivator's mind will be analysed as carefully and methodically as the soil on which he is persuaded to grow crops by up-to-date processes for European markets.

From these general observations and the fact that the Sudan is essentially an agricultural and pastoral country it is clear that immense importance attaches to the work of those concerned with scientific investigations, in condensing the results of their labours into simple rules for the guidance of the cultivator. Equally vital is the need for the spread of a system of elementary vernacular education, which will eventually enable the pioneers of enlightened methods to carry with them the sympathies of the cultivating population.

Satisfactory advance has been made in both these directions.

A country confronted with financial and economic difficulties such as those which the Sudan has had to face, has necessarily been primarily concerned with that side of scientific and technical work which is most likely to lead to immediate practical results. Circumstances have demanded, as a preliminary step, a rough scientific reconnaissance, designed to discover the most profitable lines of progress possible with the simple apparatus available.

Much valuable material has been brought to light, but in a country of an area of nearly 1,000,000 square miles, which has only recently been occupied, it is no light task to decide which of the thousand and one claims to attention merit first treatment, or, when priority has been settled, to contrive means adequate to secure the object in view.

The Sudan, it must be remembered, is still in a state of transition. For instance, the penetration of the railway into the interior has caused the economic centre of gravity to shift southwards, with the consequence that much of the scientific and technical work, necessarily confined in the earlier days to the study of conditions in the Khartoum district and the northern parts of the Sudan, though not wasted, possesses now only an indirect relationship to some of the principal demands of the moment and of the immediate future.

Circumstances have changed and efforts can now be concentrated on the root problem. Preliminary skirmishes are over. The main battle has commenced and the Sudan can now see clearly before it the object of its aims. Speaking from the economic point of view, its main task is to promote such conditions as will render cotton growing in the Gezira a permanent success.

That existing conditions lend themselves in the most providential manner to this form of enterprise is already patent, but that is no reason for not making assurance doubly sure.

The foregoing remarks are sufficient to show that considerable progress has been made in providing the elements of equipment necessary for economic progress.

Time is too limited to enable any reference to be made either to the detail of scientific investigations of the resources of the country or to the profound economic influence of the form of educational system which is gradually being constructed.

Similar reasons preclude more than a passing allusion to other factors of great importance in the economic situation, as, for instance, to the effect of the abolition of slavery and the policy whereby the native has been secured undisturbed possession of his land.

Problems of development in the Sudan all hinge on one or another of three prime considerations. These are, the extension of transport facilities, provision of water for cultivation, and labour supply.

The railway problem, which is the core of the transport question, is more than half solved. One thousand five hundred miles of railway are now working. It is a somewhat striking accomplishment that goods can be forwarded direct by through booking between Alexandria and El Obeid, 2,000 miles away in the heart of Kordofan, and between Gambela, on the upper reaches of the Baro river, in Abyssinia, and Port Sudan, a distance of 1,367 miles.

The railways and rivers, the latter of which still constitute the great highways of commerce in the interior, are complementary to one another in the service they render to trade, and in the organization of transport facilities effect is being given to this idea of interdependence of rail and river as the basis of commercial expansion.

A network of roads, of a quality suited to the present simple needs of the localities they serve, is gradually being created, in order to feed traffic to the railways and steamers, and special attention is being given to the provision of additional wells, which have an important influence not only in facilitating the movement of internal trade but also in leading to the formation of new villages.

An important question connected with roads and communications is the feasibility of introducing motor transport in certain parts of the Southern Sudan, so as to avoid the wasteful carrier system, and also to overcome difficulties arising from the mortality of transport animals in districts infected by tsetse fly.

As regards water for cultivation, it should perhaps be added that the Gezira scheme is not the only project at present in view, or indeed the only one on which work has been commenced. Over 100,000 acres are gradually being brought under cultivation in Dongola Province by means of a system of basin irrigation, and considerable work has been done in studying the possibility of controlling the flood water of the river Baraka, which supplies Tokar with the means of carrying on cotton cultivation. Plans have also been devised for dealing with a somewhat similar stream, the Gash, which has formed a large delta of highly fertile land near Kassala in the Eastern Sudan, eminently suitable for cotton and other crops.

It is estimated that with better control of the flow of the flood some 80,000 acres might be regularly cultivated at Tokar, and some 200,000 acres at Kassala.

Over and above these specialised forms of agriculture there is the large problem of improving the primitive methods by which the industry is carried on by the population in general. Reforms must necessarily be very slow, and the rate of progress is largely a question of staff, to provide instruction and demonstration. Possibly it may be found that some application of dry farming principles will have an important influence on this question. Some small experiments of this kind have been begun.

The Sudan is singularly fortunate in that cotton and its staple crops represent articles of consumption in world-wide demand. In the opinion of competent authorities they are not likely to suffer from adverse fluctuations in price for many years to come.

On irrigated estates, the Sudan can produce some of the best long-stapled cotton in the market, and there is no need to enlarge on the prospects of the world's future demand for cotton of this description.

There is good reason to believe that in other parts of the Sudan, where irrigation is not likely to be available, good long-stapled American cotton can be substituted for the degraded type of Egyptian cotton which the native has been in the habit of growing for centuries as a rain crop.

Similar market conditions apply to another Sudan product, to which only a brief reference is possible.

The Sudan is a pastoral as well as an agricultural country, and already reckons the numbers of its cattle, sheep and goats in millions.

The difficulty which Europe is experiencing in keeping pace with the growing demand for meat is too well known to need description. An important trade in the export of live cattle and sheep to Egypt from the Sudan has already been established, and it is possible to look forward with confidence to the time when there will be a large export to Europe from the Sudan either of chilled or frozen meat or of some other form of animal products. It is as certain that European interest will concentrate on the Sudan as a source of meat supply, as that the country's cotton possibilities would attract attention.

The Sudan possesses two other products which are in universal and increasing demand abroad. These are grain and oil seeds.

Wheat will form an important rotation crop in the Gezira, and will also be the principal commercial crop on the basin schemes which are being brought into working in Dongola. Wheats from Dongola and those grown at Tayiba in the Gezira are pronounced by experts to compare favourably with the better class Indian wheats. They should sell for good prices on the European market when they are produced in quantity.

Among other grains it has been shown that Sorghum (Dura), the staple food crop of nearly the whole population, has a decided export value, as an equivalent to maize, as food for animals.

Of the oil seeds, sesame is already exported in considerable quantities, and will probably play an important part as a paying crop under the Gezira irrigation scheme. Ground nuts are also successfully grown, and may prove of much value as a rotation crop. Castor seed grows with the profusion of a weed in many districts of the Sudan, but it is not yet exported.

Reference should also be made to the great value of gum arabic, both to the native population and also to the Government as a source of revenue. The average annual value of this export for the last three years has exceeded £E.470,000.

Another useful asset is possibly to be found in the valuable fibres which occur in the Southern Sudan. Their exploitation, however, will involve time and careful study. Difficulties as to labour and cost of transport preclude any likelihood of rapid development.

Although it may be fairly claimed, on the grounds which have been mentioned, that the Sudan offers a prospect of considerable commercial expansion in the comparatively near future, care must be taken to retain a due sense of proportion in the enumeration of factors which lead to progress. The country is only at the commencement of its career and, indeed, is still in its infancy. The realization of its destiny can only be accomplished by slow degrees, for the reason that time must be afforded to allow the population to increase sufficiently to provide the most necessary element in production.

Meanwhile, the construction of new railways and the fruition of irrigation schemes will probably cause periodical accelerations in the rate of output which will possibly come as a surprise to those who have not been constantly in touch with the course of development. Now that the Sudan has made good progress towards becoming a prosperous and self-supporting community the fulfilment of its greater hopes can be awaited with patience.

THE ECONOMIC RESOURCES OF BRITISH SOMALILAND.

By R. E. Drake-Brockman, M.R.C.S.Eng., L.R.C.P.Lond.

The British Protectorate of Somaliland is estimated to have an area of some 58,000 square miles, with a coast line of about 450 miles in length. This extensive area might conveniently be divided into a coast belt of from 30 to 50 miles in width and an internal plateau; the altitude of the latter may be taken as varying between 2,500 and 6,000 ft., the latter height only being reached on the mountain ranges. It is necessary here to state that only a small portion of this huge area is known at all well. The whole eastern and south-eastern parts comprising the Habr Toljaala, Warsangeli, Mijertain and Dulbahanta countries have been left practically unexplored owing to the activities of the Mullah Mahommed Abdullah Hassan, while in the northern parts the whole of the Gudabirsi and Esa countries are unknown except to a few sportsmen who have rapidly traversed them in quest of big game.

Somaliland being the habitat of a nomadic race it stands to reason that little save the breeding of livestock has ever engaged the attention of its inhabitants, consequently it is difficult to predict whether the future economic prosperity of the Protectorate, when the internal affairs of the country are in a more settled state, will be based on stock-raising, agricultural production or minerals.

As regards the last of the three, namely, minerals, nothing can yet be said owing to the lack of information regarding the country as a whole and the eastern portion in particular. Oil shales have been discovered within a few miles of the coast town of Berbera and according to native reports there are other similar deposits elsewhere. With respect to valuable minerals and precious stones very little is known, so for the present it would be imprudent to hazard an opinion.

Stock-raising has been the only occupation of the inhabitants since the earliest times. Camels, ponies, donkeys, sheep and goats comprise the sole wealth of these nomadic people.

Agricultural production, with the sole exception of a few acres around the "tarikas" or mullahs' settlements in certain localities has never been attempted owing to the fact that the very existence of the stock, the Somali's sole means of subsistence, necessitates the nomadic life.

Notwithstanding, however, his wandering proclivities the Somali is a born trader, and as soon as he finds out that any of the products of his country have a market value he is not slow to avail himself of this knowledge.

For centuries he has brought down to the coast for barter or for sale myrrh, frankincense, scented bdellium, gums and ostrich feathers, the products of the interior, and this notwithstanding his caravans being frequently looted en route. He cannot be expected to do more as long as his country is in the same unsettled state. It is wonderful that the exports remain as high as they do.

Before dealing separately with the resources of the country I should here like to digress and make a few remarks about the water supply.

The Somali country, and that part in particular which is painted crimson on the map, is frequently designated "waterless" and "a desert" owing to the fact that there are no flowing rivers or streams. Were the rainfall sufficient to produce them they would however soon be lost owing to the porous nature of the soil. Notwithstanding this the country is by no means waterless—numerous permanent springs exist throughout the country, especially in the more mountainous parts, but as the water is only required by the Somali for his domestic needs it is allowed to flow away and disappear beneath the surface and thence find its way to the sea.

At Dubar, in the maritime hills, hot springs exist and the water from these, before it was required for the town of Berbera seven miles away, disappeared into the sand soon after it emerged from the rocks. To-day these springs, owing to the water being collected in tanks and passed on in pipes, supply the entire town of Berbera with its European population and its 30,000 native inhabitants, not to mention the numerous gardens in the residential quarter or Shaab.

In the same manner the springs at Bihendula, Armaleh, Daraas, Shamahaleh, Upper Sheikh and Harawa in the Gudabirsi country, only to mention a few of those that recur to the writer, might easily be dealt with and at no very great cost.

In localities less favoured, dams as in South Africa could be made. This particularly refers to the stock-raising areas such as the Arori and Toyo plains and the great plains in the west and the Nogal Valley.

Wells could be sunk and water doubtless obtained in places where the existence of water to-day is unknown.

With a careful conservation and regulation of the existing water-supply a great deal could be done in the way of agricultural production which to-day is unheard of.

Livestock.

Camels.—Somali camels have never been exported probably owing to the fact that they have never been trained for riding purposes. The Somalis seem to have some rooted objection to using their camels in this way. These animals are used locally for three purposes only. Firstly, there are beasts of burden for transporting their huts from one grazing ground to another; secondly, a few are castrated and fattened for slaughter; and, thirdly, the females are kept for milk. Somalis prefer camel's milk in any stage to that of cows or goats chiefly owing to its antiscorbutic properties.

There appears to be no valid reason why the Somali camel should not, like his Arab congener, be trained to the saddle. Even if there was no outside demand for them there would be a sufficient sale for them in the country. Camel skins are used locally in the manufacture of sandals or Somali shoes. A Somali's wealth is reckoned by the number of camels he owns.

Sheep and Goats.—Sheep and goats can be taken together as both are weekly exported to Aden in large numbers for the consumption of the garrison and the inhabitants. Aden almost entirely depends on British Somaliland for its meat supply. When the sheep are well fed and watered their mutton would be difficult, as regards quality, to beat anywhere. The average number exported yearly is from 70,000 to 80,000, and this might under better conditions be considerably increased.

Ponies.—With the country at peace, Somali ponies though small (they seldom exceed 13 hands) could be bred in large numbers throughout the interior and exported to East Africa, where there is always a growing demand for them. The eastern or Bari pony is a particularly hardy little animal which does not require to be shod and will live for long periods on poor grazing and watering only once in two or three days.

Donkeys and Mules.—Every Somali "rer" possesses two or three donkeys. They are chiefly used for transporting the aged women and little children when moving. They are mainly bred by the Ogaden and western Somalis and there is little demand for them.

Mules are not bred by the Somalis at all. They are occasionally imported from Abyssinia, where the Gallas breed them, but there is no reason why they should not be bred on the western plains and exported to East Africa, where there is always a good sale for them.

Ostriches.—Ostriches are reared from the eggs of the wild birds by the Midgans, an outcast race who live among the Somalis in small colonies in certain parts of the country. There is no systematic breeding of the birds although the country is an ideal one for the purpose. There is always a good market in Aden for the feathers.

Animal Products.

Skins and Hides.—The enormous numbers of skins, chiefly sheep-skins, and hides which are weekly exported give, together with the export of the living animals, some idea of the large numbers of sheep in the Somali country. With the country in a more settled state, the export of skins would be considerably increased as the increase in the stock would necessitate a greater slaughter and more skins would find their way down to the coast.

Ghee.—Large quantities of ghee or native butter are yearly exported. It is of excellent quality and superior to that imported from India. The present yearly export is some 3,000-4,000 cwts., valued at something over £12,000, and doubtless this would be increased under better conditions. The greater proportion of this comes down to Zeyla and Bulhar from the western tribes. About two-thirds of the total amount is exported from Zeyla to Aden, Djibonti and Perim, while practically all the remainder goes from Bulhar to Aden.

Vegetable Products.

Myrrh.—There has been a great deal of confusion as to which species really produces the best myrrh exported from the Somali country.

The Somali recognizes two varieties of myrrh, namely, "Ogo malmal" and "Guban malmal," according to whether the myrrh comes from the interior or the coast-belt. He, however, only recognizes one myrrh-producing tree, which he calls "Didin."

Until quite recently the source of all the myrrh collected in the Somali country was supposed to be the trees scientifically known as *Balsamodendron Myrrha*, Nees, but this will probably be found to be incorrect when all the specimens sent to Kew for identification have been thoroughly worked out.

There are unquestionably two varieties of *Balsamodendron Myrrha*, Nees, found growing side by side on Guban, the low-lying coastal belt which includes the maritime hills. These two trees, owing to the darker appearance of one of them, are called by the Somalis "Didin ad" and "Didin madow"—the white and black myrrh trees respectively. Both these varieties produce the Guban malmal.

The source of the Ogo malmal is a species which has yet to be identified. The tree is superior in size to, and the foliage thicker than, the myrrh tree of the coast, but whether this difference is due to the superior conditions under which it thrives in the interior has yet to be determined.

Large quantities of myrrh have been exported from the Somali country from the earliest times. The myrrh is collected in the same crude fashion and brought to the coast in the same way as it was in the days of King Solomon. No attempt whatsoever is made either to protect the trees from damage or to judiciously incise them and thus increase the supply.

Frankincense.—Two varieties of frankincense are known commercially by their Arab names, "Loban Dakar" and "Loban Maidi."

The former, "Loban Dakar," is the less valuable of the two and is the product of the "Mohor" tree (*Boswellia Carteri*, Birdw.). This tree only grows in the eastern parts of the British Protectorate—in the Habr Toljaala, Warsangeli and Mijertain countries.

"Loban Maidi," the more valuable of the two, is obtained from the "Yehar" tree (*Boswellia Frereana*, Birdw.), and is also found in the eastern parts of British Somaliland.

Bdellium.—Of the Somali bdelliums, "Habbak Haddi" or "perfumed bdellium" is the most valuable. It is brought to the coast from the far interior packed in separate skin-bags, and is easily recognized by its pleasant aromatic scent.

The tree producing it, which is known to the Somalis as "Haddi," is said by Mr. E. M. Holmes to be *Commiphora erythraea* var. *glabrescens*, Engler. The present writer has never seen the tree growing nor been able to get botanical specimens for identification.

There are numerous other bdelliums used locally in a small way by the Somalis, but these appear to have little or no commercial value. As some of these are at present being investigated, it would not be advisable to say anything about them until a future date.[1]

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[1] The results of examination of these bdelliums at the Imperial Institute, as well as those of samples of myrrh, frankincense, and gum from Somaliland, have now been published in the *Bulletin of the Imperial Institute*, vol. xii (1914), pp. 11-27.

Gums.—Commercially only one or two of the acacia gums have any value and the most important of these is the gum of the "Adad" tree (*Acacia Verek*, G. and P.). The gum of this tree is found in large globules or irregular lumps and tears, and when freshly exuded is colourless.

In the western parts of Somaliland, chiefly in the vicinity of the rivers Shebeleh, Genale, Wabi and Juba, the "Wadi" acacia is very common and the gum collected from it, although slightly inferior to the "Adad" gum, has a fair market value. It is seldom mixed with "Adad" gum as these two gums are brought down to the coast by different tribes.

Most of the gums of the other acacias, such as the "Marra," "Galol," "Gurha," "Sog-sog," etc., are so deeply pigmented, some being of a dark port wine or even purple colour, that they have no market value and consequently are never collected by the Somalis.

The total annual export of myrrh, frankincense, scented bdellium and gum arabic is about 7,000 to 8,000 lb. The output might easily be increased if the trees were protected and judiciously tapped.

Fibres.—(1) *Sansevieria Ehrenbergii*, Schwein.—Somali name: "Hig." This fibre has always been used by the Somalis in the manufacture of their camel ropes. Even when cleaned by hand after the rough and ready native methods it fetches a good price on the London market. It is classed with the best Sisal hemp, and when properly cleaned should command from £34 to £35 per ton.

This Sansevieria is very common throughout the country and the supply is practically unlimited. An attempt has already been made to exploit it but owing to the troubles in the interior the project had to be abandoned.

(2) *Sansevieria guineenis*, Willd.—Somali name "Dig wein." This species only grows sparingly in favourable localities and owing to the shortness of the leaves is not likely to be as valuable as the foregoing. The fibre is used occasionally by the Somalis and appears to be finer and softer than the fibre of *S. Ehrenbergii*.

(3) *Calotropis procera*, R. Br.—The bast fibre from

this bush, known to the Somalis by the name "Bo'o," is prepared in the following manner. The long green branches are incised in a circular manner around their thicker ends and the thin green bark peeled off in long strips. The bast is then stripped from the remainder and put inside until required. The process of cleaning, which is done entirely by the old women, is a long one as small quantities are chewed at a time, the fibre being kept in the mouth until quite clean and the juice spat out from time to time. The fibre when sufficiently clean is then stretched out to dry and later twisted by hand into thin string, which is used at the coast for fishing lines and other purposes.

(4) *Acacias.*—The bast fibre obtained from the "Galol" (*Acacia* sp. allied to *A. latronum*, Willd.) is prepared in a manner similar to the above, only it is customary for the women when chewing the "Galol" to swallow their saliva. This fibre is of a reddish colour and is also used for making string.

Bast fibres which are very commonly used among the Somalis are also prepared from two other acacias, namely the "Gurha" (*Acacia Seyal*, Del.) and the "Khansa" (*Acacia nubica*, Benth.). The former is the better of the two and from it a very strong light rope is prepared by the women. It can as a rule be very easily distinguished from the Galol rope after it has been in use a few days as the former soon takes on a dark reddish colour.

Tanning materials.—(1) *Watta leaves.*—The "Watta" (*Osyris abyssinica*, Hochst.) is a common bush on the Golis Range and is frequently used by the Midgans for tanning purposes. As the leather it produces is of a more or less pinkish-fawn colour, the native tanners often mix Marra seedpods with it to give the leather a dark reddish colour. Only the leaves and the tender tips of the branches are used and when these are carefully collected the total matter absorbed by hide powder may be from 23 to 26 per cent.

(2) *Marra bark and seedpods.*—The "Marra" (*Acacia arabica* var.?) is a very common tree throughout Somaliland and is more commonly used for tanning

than any of the others. Both the bark and the ripe dry seedpods are used. Of the two the seedpods are the more valuable and contain on an average from 20 to 30 per cent. of tannin. When the unripe seedpods are collected they are carefully dried in the sun before being exposed for sale.

(3) *Galol bark.*—The "Galol" tree is as common as the "Marra." It is a species of *Acacia* allied to *A. latronum*, and as a rule only the thin bark stripped from the root of the tree is used. This bark is comparatively rich in tannin, practically the same as the "Watta" leaves, but the leather produced is of a darker colour and not quite so good. The total matter absorbed by hide powder is from 23 to 27 per cent.

(4) *Jirma bark.*—The bark of this species of *Acacia* is very commonly used in the town of Zeyla. At present I have been unable to identify the tree, only having seen the bark. It is said by the natives to be as good as the "Marra."

(5) *Mangrove bark.*—There are two varieties of mangrove known to the Somalis, namely, "Gandallo" (*Rhizophora mucronata*, Lam.) and "Takai" (*Avicennia officinalis*, Linn.) Both these are found at various places along the coast but I have not heard of the bark of either being used for tanning purposes. Both grow freely on the island of Saad-ud-din, near Zeyla. The trunks and the larger branches of both these trees are used by the inhabitants of Zeyla in the construction of their huts and houses.

Timber.—Somaliland is not a country where one would expect to find valuable timber but there are one or two trees which are certainly of economic importance. Of these the juniper (*Juniperus procera*, Hochst.) known to the Somalis as "Dthiyib," and the box (*Buxus Hildebrandtii*, Baill.), called "Dossogh," are the best known. Although it would scarcely pay to export the former, even if it were found in sufficient quantities, the latter, which is very common and grows freely all over the Golis Range, Wagar mountain and other suitable localities, should be of value. The boles appear to be of sufficient thickness, straightness and length to demand a sale.

Other woods, such as the numerous species of *Acacia* and *Balanites*, which are largely used by the coast Somalis for the manufacture of charcoal, are resistant to termites and are worthy of consideration.

Grass.—Throughout the Haud there grows in large clumps a tall coarse grass, six feet or more in height, called by the Somalis "Durr." This grass, of which there are two species (*Andropogon cyrtocladus*, Stapf, and *A. Kelleri*, Hack.), is of little or no use for grazing purposes but it might be of value in the manufacture of paper. Owing however to its only being found in the Haud and Nogal Valley, a great distance from the coast, it would hardly pay to convey it to the coast for export. If however it could be treated in the interior with caustic soda and then brought down it would probably be of value.

Dates.—Some parts of the coastline of the British Protectorate of Somaliland are admirably suited to the growth of the date palm. This is quite obvious even to the uninitiated, for the palms in the gardens of Dubar and Berbera speak for themselves. At Bulhar there is an ideal stretch of country several miles in length where the date palm would flourish with very little care. There can be no doubt that anyone seriously taking up the culture of the date palm will be handsomely rewarded for his pains within a few years. When it is considered that the yearly import of dates into the country is between 40,000 and 50,000 cwts., valued at over £14,000, it can be easily seen that any attempt to grow the fruit locally is certain to meet with success. Whatever may be the taste of the Somalis the Arabs infinitely prefer the fresh date to the imported one. Those who have tasted the dates grown in the Berbera gardens know that not only are they of excellent quality and size but that the Arabs will pay for them two and three times the price of the imported dates. The sole reason why this obviously payable industry has not already been started is the unsettled state of the affairs of the country. When once started there is no reason why dates should not take their place on the export instead, as now, on the import list.

Coffee.—The present writer has long held the belief that the Golis Range would be an ideal locality for the growing of coffee. Owing to the scarcity of water however it would be only possible in certain favoured localities. The coffee grown in the Harrar Province of Abyssinia and in the mountains of the Yemen, in Arabia, is the finest in the world, and the conditions are somewhat similar to those existing on the Golis Range in British Somaliland. The difference in altitude should make little or no difference to the growth of the coffee. On the Golis Range it could be grown at an altitude between four and five thousand feet.

Jowari.—Jowari, or Dhurra, as it is sometimes called, is to-day grown on a small scale only for local consumption around the tarikas or Mullahs' settlements in places such as Upper Sheikh and Hahi, but owing to the uncertainty of the rainfall it could hardly be grown in paying quantities. In the best of seasons it could only be grown for local needs.

Tobacco.—The tobacco plant grows well both at the coast and in the interior. The locality most suitable for its growth would probably be the foothills of the Golis Range.

The Levantine tobaccos would probably thrive better that the others but there is no reason why the Virginian should not also be a success. Only experiment can settle the question as to which is the most profitable crop to plant.

Manure in the shape of guano is not difficult to procure as it can be obtained in fair quantities from the island of Mait, from whence the Arabs have procured it from time immemorial for the fertilization of their tobacco plantations at Makalla.

Cotton.—Cotton could be grown anywhere provided irrigation could be employed, but the rainfall is too erratic as a rule for rain crops to be very successful. No experiments have been made with the different varieties, though one variety appears to thrive in the gardens in Berbera and at Upper Sheikh. The present writer is of opinion however that the land might be more profitably used in the planting of more valuable crops than cotton, especially as the latter is now grown to such a large extent in the Sudan and in Uganda.

Floss or Silk-Cotton.—The "Bo'o" (*Calotropis procera*), which has been mentioned already (p. 494), is a common plant in British Somaliland, and this is particularly the case outside the town of Bulhar, where there are several acres of it growing for a mile or more along the coast.

The floss around the seeds has been used by the Arabs and the Somalis in the towns for stuffing their pillows, and if cultivated on a large scale might be useful in upholstery.

Furthermore, as machinery has of late years been invented for the spinning of this and similar flosses, materials could be manufactured from it. It grows in such profusion in Bulhar, the soil of which seems particularly suited to it, that the further cultivation of it would be worth a trial. For several miles along the coast-line, both east and west of the town of Bulhar, the plant could be grown as there is always a plentiful supply of slightly brackish water within six or eight feet of the surface.

Mineral Products.

Little or nothing is known of the mineralogy of Somaliland and until experts have examined the country nothing can be stated definitely.

At Kirrit, in the Ain Valley, there is a thick and what appears to be a valuable seam of alabaster, but unless a railway happened to pass within a short distance of the spot the cost of transport would be too heavy.

Oil.—It is at present difficult to express any opinion as to the value of the native reports concerning the presence or absence of oil-shale in the Protectorate. Only recently a deposit, the extent of which is at present unknown, was discovered within 30 miles of Berbera and should this prove a rich field there should be no difficulty, after distilling the light petroleum, kerosene and lubricating oils, in conveying them in pipes to Berbera, where there is an excellent harbour.

Samples from this deposit have already been submitted for expert opinion.

With the country at peace, small bodies of Somalis of different tribes might be trained and sent throughout the country to the areas occupied by their respective tribes to look for petroliferous shales; in the coast regions to the east especially, there is little doubt that other deposits might be discovered. Once the value of an oil-field is explained to him the Somali is intelligent enough to hunt for them and in this way a rough survey of a considerable part of the Protectorate might be made at little cost, prior to the subjugation of the Mullah and his followers who, to-day, according to native report, occupy a country where oil-shales are said to exist.

INTORNO ALLA FLORA DELLA SOMALIA ITALIANA MERIDIONALE.

Per il Professore Guido Paoli.

La Somalia Italiana Meridionale si presenta con un aspetto botanico ben caratterizzato; in essa mancano del tutto le formazioni desertiche, poichè il suolo è completamente ricoperto di vegetazione.

La flora è costituita in prevalenza da piante di tipo xerofilo; si hanno nonostante anche formazioni di idrofite e igrofite più o meno commiste fra loro; tali le foreste lungo il Giuba, le quali si estendono quasi senza interruzione lungo le sue sponde, ma non in grande profondità, formando delle vere foreste a galleria. Lungo il fiume medesimo, specialmente nel tratto inferiore del corso, si trovano molte regioni paludose, nelle quali vive una flora pulustre particolare; altra regione simile è quella dei Balli nella quale si persono le acque dell'Uebi Scebeli e forse di altri corsi d'acqua temporanei.

Alla foce del Giuba poi, e in qualche altro punto della costa, come a Gezira, si trova sviluppata la formazione a Mangrovie colle solite essenze, *Rhizophora*, *Avicennia* ecc.

Tolte queste regioni occupate da piante proprie dei terreni umidi e sommersi, tutta la rimanente flora è costituita da piante xerofile nel senso più assoluto ma si possono ciononostante distingure diverse regioni assai ben differenziate fra loro in riguardo specialmente alla natura del suolo.

Cominciando dal littorale, si hanno prima le sabbie costiere e dune mobili le quali però sono molto limitate e quivi si trova la flora alofila consueta.

Dietro a questa striscia littoranea cominciano altre dune ormai fissatee coperte di vegetazione e queste sono molta sviluppate formando una zona parrallela alla costa di profondità che supera anche i 20 Km., e di altezza spesso maggiore di 100 metri; il suolo, come bene si capisce, è sabbioso, ma profondamente alterato, ricco di particelle calcaree e di sali di ferro, e a causa della sua natura sempre molto asciutto. Queste dune sono rivestire di boscaglia abbastanza folta in cui il predominio assoluto è delle acacie basse, ma fra queste emergono numerose acacie ad ombrella (*Acacia tortilis* ed altre).

Oltrepassata la serie delle dune si incontra una vastissima zona alluvionale, percorsa dal Giuba e dall'Uebi Sc beli, e questa è per la maggior parte occupata da praterie steppose che all'epoca delle pioggie si vedono formate da una fortissima associazione di piante erbacee alte circa 50 c/m con predominio di graminacee, più rare sono le ciperacee e le leguminose; in alcuni punti specialmente lungo il basso Giuba la prateria è costituita da graminacee alte da uno a due metri ma sempre foltissime; spesso, specialmente nella prateria bassa, si ha la formazione a parco, dovuta alla presenza di alberi non molto alti, assai distanziati fra loro, appartenenti per lo più ai generi *Acacia* e *Terminalia.* Al termine di questa zona alluvionale continua la pianura ma il suolo è invece di origine generalmente calcareo, talora eluviale, talora roccioso, come nella zona collinosa più interna presso il contatto fra la regione calcarea e quella alluvionale si trovano delle isole di pianura in cui il terreno sabbioso siliceo deriva dal disfacimento di rocce granitiche, le quali anche qua e là affiorano ed emergano formando delle caratteristiche colline isolate (*Bur*). La Flora è assai diversa nel terreno calcareo da quella del terreno siliceo sabbioso o roccioso, e non solo per le diverse specie che vi si trovano quanto e più per la fisonomia delle associazioni vegetali.

Nei terreni calcarei si ha la boscaglia caratteristica prettamette xerofila, secca per la più grande parte dell'anno, costituita da piante basse, a rami tortuosissimi, generalmente munite di spine o di rami spiniformi a foglie ridottissime; scarse sono le piante succolente, ma al contrario abbondano quelle con radici ingrossate, tuberiformi, bulbose, ecc. Vi predominano le acacie rappresentate da molte specie; questa boscaglia è in genere molto folta e tra gli alberi e gli arbusti crescono poche piante erbacee.

Nelle sabbie granitiche invece la vegetazione è più rada ma più grandiosa e ricorda assai da vicino la formazione a parco; gli alberi sono più alti; tolte le rare acacie e qualche altra pianta, sono privi di spine con rami più diritti, foglie più grandi, le quali restano anche più a lungo sulla pianta, in modo che qui l'aspetto xerofilo è assai meno accentuato; anche la vegetazione erbacea è assai abbondante e rappresentata da graminacee, ciperacee e leguminose diverse. Inoltre intorno ai rilievi granitici detti *Bur* si trovano frequenti le *Adansonia* e urticacee del genere *Ficus*, solite a vivere in vicinanza delle acque. Non mancano anche nei terreni calcarei, delle zone in cui la vegetazione è lussureggiante e di tipo non molto xerofilo, come ad es. in una vasta zona interna lungo il corso del Baidoa e nelle regioni circostanti.

Prededendo verso l'interno incominciano, poco prima di Lugh i terreni gessosi, ma la flora presenta ancora lo stesso aspetto prettamente xerofilo come in quelli calcarei; in più si aggiungono molte essenze particolari gipsofile e anche alofile, e queste ultime si trovano dove le acque ristagnando nella stagione delle pioggie lasciano evaporandosi un terreno impregnato di salgemma.

Le coltivazioni indigene sono poco variate; si trovano nelle alluvioni specialmente del Giuba e dell'Uebi Scebeli e ovunque si abbiano terreni argillosi, anch'essi di origine alluvionale, come intorno a Bardera o nella vasta regione interna detta dei Baidoa.

Le piante coltivate dagli indigeni sono dura e mais; questo in prevalenza su quella lungo il basso Giuba e l'Uebi Scebeli; ma lungo il corso superiore del Giuba, nel Baidoa e altrove si coltiva soltanto dura; il cotone arboreo è coltivato scarsamente ovunque, ma più frequentemente lungo lo Scebeli, ove si coltiva quà e là anche il tabacco.

THE ECONOMIC RESOURCES OF THE TERRITORIES OF THE COMPANHIA DO NYASSA.

By VICENTE ALMEIDA D'ECA.

General Secretary of the Companhia do Nyassa.

THE Territories of the concession of the Companhia do Nyassa are situated in the most northerly part of the Province of Mozambique and are bounded on the east by the Indian ocean, on the north by the River Rovuma as far as its confluence with the River Msinge, and thence by a parallel line up to Lake Nyasa, on the west by Lake Nyasa and the Anglo-Portuguese Frontier, and on the south by the River Lurio.

These Territories comprise an area of about 200,000 square kilometres. At the date of the Charter of Concession (21st September, 1891) effective dominion was exercised over the Island of Ibo, where the town of Ibo had existed for centuries, and at Tungue, which had been in military occupation since 1887 when operations were directed against the forces of the Sultan of Zanzibar. Other islands of the coast had been occupied a long time before this, but the attacks of the Arabs and Sakalaves in the 17th and 18th centuries had led to their abandonment.

The Companhia do Nyassa did not take official possession of the Territories until October, 1894, and this possession was confined to occupying the above mentioned localities. Its first work, therefore, was to obtain effective possession of all the Territories, the administration and exploitation of which had been conceded to it. On this first and principal work, the Company has been employed for twenty years, and, by means of successive advances in penetrating lines and enveloping circles, it has carried out the most essential part of this effective occupation. The latest steps undertaken were the occupation of the lands of the famous chieftain Mataka in 1912 and the commencement of the occupation of the Makonde district in 1913; but some work still remains to be done in the district watered by the middle Lurio, and also in that to the west of the Makonde district. It must be remembered in this connection that the area of the Territories is more than twice that of Portugal, and that none of the rivers permit of free navigation.

The first technical party to explore the Territories of the concession was despatched in 1894 before the Company took official possession. Other parties were afterwards sent out, the latest being in 1912, for the purpose of surveying the route for the railway from Pemba Bay to Lake Nyasa. Sub-concessionaire companies also have investigated the mineral and vegetable resources. Successive Governors and Commandants of Columns of occupation have also supplied information relating to the various aspects of the Territories. From these sources of information the present report has been compiled.

The Territories from an Agricultural Point of View.

The Territories of the Companhia do Nyassa, owing to their geographical situation between parallels 11° and 14° S., are naturally adapted for the cultivation of all products that flourish in tropical and sub-tropical regions.

Generally speaking, and excepting the Makonde plateau, it may be said that the level of the country gradually rises from the coast to Lake Nyasa, in such a way as to render possible its division into three natural zones, the *coastal*, *middle*, and *interior*, each of which has well-defined characteristics.

The first zone is naturally warm and humid, especially in the north, but it is free from marshes, and therefore much healthier than other African districts in the same latitude.

The coastal zone is rather narrow in the south, where it quickly gives place to the second zone, which extends as far as the Lugenda, and is characterized by a series of uplands, each one more elevated than the last, broken by small ravines or isolated hills and sometimes by solitary rocks of large, grotesque shape. The average altitude does not exceed 500 metres, and the land in general is well wooded and plentifully watered, offering excellent conditions for agriculture.

Finally, the high or mountainous zone, the more elevated parts of which are really cold, is characterized by the Ajaus mountains, with an altitude of about 2,000 metres, and is considered as being the richest of all as regards fauna and flora.

With reference to the conditions for agricultural exploitation the Territories of Portuguese Nyasa may be divided into the following districts:—

Coconut District.—The whole coastal zone.

Pastoral and Cattle Raising District.—Between the rivers Rovuma and Msalu, and also some of the islands.

Rubber and Copal District.—The basin of the lower Msalu, the very vast Makonde district.

Sesame District.—From Pemba to the river Lurio.

Wax District.—The hills of Medo-Lualia.

Coffee District.—The upper Lugenda, and the islands of the sea-coast.

Cotton District.—The Ajaus mountains and Amaramba.

It is needless to say that this division must not be taken too rigidly. Many of the products may be cultivated in more than one region. For example, coffee, cotton, different rubber-producing plants, and also the sugar-cane, which has no special district, flourish in all parts where there are rivers, both on the coast and in the interior.

Except perhaps for any botanical speciality, which can only be discovered by a very careful exploration, "the Territories of the Company do not possess a distinctive and characteristic flora, or any land that is exceptional for any reason, or any native population which is peculiar to it, which would differentiate them from the remainder of the Province of Mozambique. The lands are generally fertile and although not possessing a dense and luxuriant vegetation, such as is found in Java, Brazil, St. Thomé, or the Congo, we are able to boast some of the best land of the Province. In the

Nyasa Territories, as elsewhere, fertility is not equal in all parts: all districts are not uniformly rich, of the same nature, or susceptible to the same exploitation. Great variations are found, from the desert, arid, dry land, dotted with the mounds of the white ant, to the plateaux of great altitude, or to simple chains of hills which possess a temperate climate and well-cultivated, fertile soil, densely wooded and capable of producing products proper to the climate. Here, as in the south, the productive power and the potentialities of the lower lands vary, from the red, sandy soil, with scant water supply, which gives a large harvest of cereals and oil seeds, to the alluvial soil of the river mouths, banks and river islets, with all the conditions necessary for the cultivation of rich tropical products.

"In general the vegetation has the same aspect as in the south. On the coast and along the river mouths, creeks and lagoons is the inevitable mangrove, dense, hardly accessible and difficult of transport, which, unproductive up till a short time ago, is now stripped for bark in enormous quantities. In populous districts the chief product is the coconut, while the plantations of the half-castes also contain the cashew-nut tree, a spontaneous product, requiring no care. The mango tree in dense forests and other tropical fruit trees occur. There are plantations of maize, *mexoeira* and *mutama*, and in the lower and watered districts, green of aspect, is the sugar-cane, greatly enjoyed by the negro, while everywhere we find mandioca fields yielding an indispensable food. Proceeding a little into the interior, we enter the jungle, more or less dense, according to the fertility of the soil, with its useless trees, grass higher than a man, and climbing shrubs running from one side to the other, sometimes forming an impenetrable network." (Governor Vilhena, *Reports and Memoirs*, 1905, page 355.)

General Methods of Cultivation.

Prior to the Company taking effective possession of the Territories agriculture, in the modern European acceptance of the word, did not exist. It was a district given over to natives, and naturally only native methods of cultivating the soil had been in vogue.

In the kitchen gardens and plantations of Ibo and other islands where whites or half-castes live, some cultivation, even if rudimentary, was practised, but always according to native methods. It may be mentioned, however, that these methods when practised by natives of the more intelligent tribes, were, and are, superior to those of many other districts in Africa. Thus, for example, in the Mataka district (lower Lugenda), it was ascertained in October, 1912, that "in the settlement of Macocolo, where the preparation of land for the new plantations had commenced, as far as the eye could see there was land traversed by irrigation canals and dotted with mounds of cattle and goat manure, which gave one the impression that the lands were manured in order to increase their productivity. From Sarrange to Muembe, and from Muembe to Licopolo, the whole district was seen to be abundantly watered—it may be said to be one enormous plantation, partly unsown and partly covered by tobacco, cotton and flat maize." (Report of Governor Dr. Matta e Dias on Mataka Occupation, 1912.)

With the occupation of the Territories by the Company, European initiative and capital were gradually attracted, principally during the last 8 or 10 years.

The regulations for concessions for agricultural exploitation offer excellent facilities for obtaining land; in fact, the only difficulty is the question of which land to choose. For exploitation on a large scale the Company has entered into special contracts for sub-concessions.

Generally speaking, at the present time the agricultural exploitation of the Territories of the Companhia do Nyassa is carried on in the following ways:—

(*a*) Native cultivation.

(*b*) Small plantations belonging to the Company attached to the posts.

(*c*) Moderate sub-concessions.

(*d*) Large sub-concessions.

Both as regards native agriculture and that carried on by Europeans, it is necessary to distinguish between agriculture properly so-called, more or less rudimentary, and the mere collection or extraction of natural products. The principal products resulting from both methods of exploitation are dealt with in the following sections.

Rubber.

Rubber producing plants belonging to the genus *Landolphia* exist in the Territories, and although their distribution has not yet been definitely ascertained it may be said that they flourish "roughly in the district bounded by the rivers Lugenda, Rovuma and Msalu, and the Coast, from the banks of the last-named river as far as the Concelho of Quissanga, and in the north of the Lake Concelho, near the rivers Rovuma, Msinge, etc." (Governor Pires Viegas.)

The most characteristic rubber districts are the Makonde district in the eastern portion of the Territories, and in the valleys of the Msinge and Luchilingo, tributaries of the Rovuma, in the west of the Territories, the last-named having been recognized within the last few years.

With a few and unimportant exceptions which are mentioned below, the rubber is extracted by the natives by various processes, the principal of which are the "incision" and the "boiling" methods. In regard to these processes, and the general question of rubber in the Territories, what was written by Governor Vilhena on pages 378 and following of his *Reports and Memoirs* may be read with much profit. His information, which comprises a study of the subject up to 1903, is summarized below and amplified with more recent details.

The problem of the best method of extracting Landolphia rubber, although theoretically decided, is not so easy in practice. Natives preferably employ the method of "boiling," which is prejudicial to the plants and gives a product of inferior quality. Indirect means have been employed to stop this method. The first was to prohibit the exploitation of rubber extracted by boiling.

The result was that the natives, not recognizing frontiers or distances, took the rubber to the neighbouring German colony, and the merchants in the Company's Posts complained bitterly of the decrease in their business. It was thought that all the "boiled" rubber which might be met with in the Territories could be seized purely and simply, but the impracticability of this idea was recognized. At last a Customs tariff was adopted; that is, an apparently prohibitive export duty (20 per cent. ad valorem) was established upon rubber extracted by "boiling," while rubber extracted by "incision" was divided into two classes, viz., impure with an export duty of 8 per cent., and pure, with a duty of 3 per cent. In spite of this tariff "boiled" rubber continues to constitute the greater part of the exports, as will be seen from the following statement, which should be compared with that of Governor Vilhena (*Reports and Memoirs*, page 389).

RUBBER EXPORTED FROM TERRITORIES (IN KILOS).

Year	Boiling	Incision impure	Incision pure	Total
1907	121,907	17,654	—	122,561
1908	91,386	7,813	414	99,613
1909	197,858	6,225	281	204,364
1910	253,738	4,825	647	259,210
1911	138,099	7,709	23,847	169,655
1912	162,214	19,184	5,333	186,731

The impurities in the rubber obtained by incision result from two causes—imperfect processes, and methods employed to increase the weight. The merchants on receipt of balls of rubber from the natives sometimes cut them open to ascertain if they contain sand or other foreign substance.

The incision method employed by the Makondes is described in the following words by an expert eye-witness:—

"The Makonde region lies two or three days' march W.N.W. from M'tumba and is easily reached from the coast. According to Mr. Huddart's estimate, there are at present (1907) about 200 square miles of forest that are being tapped; surrounding this area is an extensive belt containing a smaller proportion of vines, due to its being of easier access to the native collectors and the consequent destruction of the vines by wrong tapping methods.

"Generally the rubber milk or latex begins to flow soon after the commencement of the rainy season (December) and continues for several months. Tapping here simply consists in climbing up the vines or supporting trees and slicing off pieces of the bark at intervals of 9 in. or a foot. In a short time the latex has exuded in the form of thick cream (a thin fluid at mid-season), which soon coagulates.

"This is then picked off and rolled into small balls, when it is ready for barter. A certain loss of weight occurs—some 5 per cent.—on the voyage to Europe. A native may collect from 12 to 24 ozs. of rubber per day, this depending on the amount of latex flowing. The chief collecting centres are the villages of Makopira, Mwanga, Mipeme and Mbico, from three to four days' march from the coast." (Mr. J. Stocks' Report to the Search Syndicate, 1907.)

With all these drawbacks the rubber of the Companhia do Nyassa was awarded a Gold Medal at the Exposition Universelle de Paris, 1900. (See Exposition Universelle de Paris, 1900: Portugal, Catalogue Officiel, page 95.)

At the Colonial Exhibition, organised by the Geographical Society of Lisbon, in 1906, the Companhia do Nyassa exhibited eighteen samples of rubber produced in the Makonde district, the Gold Medal Diploma being granted for the rubber of the Territories.

The great natural riches which exist in the Makonde District in the shape of Landolphias, and the desire to prevent its rapid extinction owing to wasteful native methods of collection, attracted the attention of European merchants. But the first attempt at pacific penetration into the district received opposition from the natives. It was not until 1913 that it became possible to commence the occupation of that extensive district. The following phrases give an idea of the difficulties of such an occupation . . . "Very dense jungle, penetration into which is dangerous, and within which the first Makonde settlements would be encountered . . . Leaving in the direction of Micumba, on our arrival at Necoto it was seen that before us there was nothing but dense jungle . . . I concluded it would be rash to send some hundreds of carriers into the jungle . . . In no district (in the Territories) have I encountered greater difficulties than those which presented themselves in the occupation of the Makonde territory. The whole region is mountainous, and covered with a dense jungle with a few clearings in the lowlands, where the natives have their plantations." (Report of Capt. Costa Campos, on Makonde Occupation, 1913.)

The extraordinary development of the rubber industry during the last 20 years indicates the necessity of introducing new species, which might be expected to produce more rubber than is now obtainable from the mere exploitation of the indigenous species. In the Territories of the Companhia do Nyassa attempts of this nature are being made by private individuals, and by the Company in small plantations attached to the Posts. The principal species which are being experimented with are *Hevea brasiliensis* (Para rubber), and *Manihot Glaziovii* (Ceara rubber). In respect of the last named Mr. Stocks wrote in 1907:—

"Up to the present time no attempt has been made in Portuguese Nyasa to cultivate rubber on a large scale. Some three years since a number of seeds of Ceara (Brazilian) rubber were distributed to various centres and planted. I have already commented on their vigorous and healthy growth at M'tumba, where some of the trees have attained a diameter of 12 in. in three years. Single plants were also growing well in some of the villages passed through in the interior. This species is found to yield the maximum amount of rubber when grown in somewhat dry, stony positions; rich alluvial soil should therefore be avoided. The trees may be tapped in their fifth year. Ceara rubber is very easy to cultivate; the seeds can be obtained from the established trees at M'tumba." (Mr. Stocks: Report to Search Syndicate, 1907.)

It remains to mention *Landolphia parviflora* (*L. Tholonii*). This indigenous species exists in large quantities in the valleys of the Msinge and Luchilingo.

and flourishes in all places which are sheltered by large forest trees. It is a shrub, rarely more than 1½ metres high, the thickness of the stalk never exceeding a centimetre. The leaves are lanceolate, of a deep green colour, and terminate in a brilliant coriaceous point; a large horizontal rhizome grows at the level of the soil which puts out 5 to 10 roots, which contain rubber, as does all the plant.

The natives knew the product of this plant, which they call Mahungo or Rurungo, and extracted the rubber by the following method, naturally destructive. The shrub was cut down and the roots torn up and cut; they were then beaten against the trunk of a tree, boiled and the latex collected. Later, even before the occupation of that district by the Company, a merchant commenced to buy roots from the natives, and proceeded to extract the rubber by a more scientific method. Near Mtengula, the headquarters of the Lake Concelho, an establishment exists for agricultural and industrial exploitation, having at its disposal steam driven machinery and other accessories. This establishment at present belongs to a Company called the Mtengula Plantations and Transport Co., Ltd., to which has been granted the right to exploit rubber producing plants over the area bounded by the valley of the Msinge and the left bank of the river Luchilingo, on the condition that this exploitation is conducted in such a way that the plants will not be destroyed.

The rubber produced in the Territories is exported principally to Germany and the United Kingdom, the latter being the destination of all the rubber exported from the Lake Concelho, which is despatched via Fort Johnson-Chinde, and figures in the statistics of the Company as being exported to British Possessions. During the 5 years 1908-1912 this exportation was as follows:—

Year	Germany Kilos	United Kingdom Kilos
1908	31,664	67,949
1909	67,369	136.753
1910	168.154	91,490
1911	17.207	152,448
1912	32,314	154,417

The Customs value of all rubber exported from the Territories in the years 1907-1912 is as follows:—

					Reis
1907	...	...	...	...	51,439,275
1908	...	...	...	...	67,032,275
1909	...	..	...	...	130,239,555
1910	...	...	...	...	152,081,011
1911	...	...	..	...	176,243,238
1912	...	...	...	...	160,986,100

The statistics given above relating to rubber, as well as those for the other products referred to in this paper, only represent that which passes through the Customs House or the Posts; the amount of contraband cannot be estimated.

Cotton.

Cotton is indigenous to most districts of the Territories and is cultivated in many of them by the natives, who know how to spin it, although clumsily. "An author has said of Nyasa cotton that it is the best in the world, its growth taking place during a much longer period than in the United States, and the natives only having to renew the plant every three years." (Governor Vilhena: *Reports and Memoirs*, page 395.) More recently Mr. Stocks writes: In view of the favourable conditions existing in the country—climatic and otherwise—cotton may well occupy a place second only to rubber. Having seen it grown so uniformly well in widely separated districts and conditions, both in a wild and cultivated state, I can only recommend that its culture be undertaken on a large scale near the coast. Egyptian cotton is the most suitable, and several standard varieties such as 'Abassi' and 'Jannovitch' should be procured in quantity direct from Egypt.

"A small quantity of 'Sea Island' cotton should also be tried, in good positions only." (Mr. Stocks: Report to Search Syndicate, 1907).

The first attempt at the cultivation of cotton by approved methods was made by the Agricultural Company of Quissanga, near the headquarters of the Concelho of that name on the sea coast.

To the Exhibition of the Geographical Society, held in Lisbon in 1906, the Companhia do Nyassa sent fourteen samples of cotton, of which only two came from the interior. The Exhibition jury awarded the Silver Medal Diploma for this cotton. In regard to this product, Governor Pires Viegas wrote: "Although the Concelhos beyond the Lugenda were not represented, I noted when I traversed the district a great quantity of cotton without special cultivation."

It was at one time supposed, as Mr. Stocks had written in 1907, that the districts adjacent to the coast were the best for the cultivation of cotton, but it is certain that even at that period the cultivation of cotton on some scale had been thought of in the Amarambo Concelho, in the south-west portion of the Territories, probably in emulation of the cultivation of this product in the neighbouring district of British Nyasaland. As a matter of fact, the first experiments were made in Amaramba in 1908 with Egyptian cotton, the seeds for which had been acquired from the plantations of British Nyasaland. As a result of these experiments it has been proved that one hectare of land is capable of producing a ton of cotton, including seeds, or 333 kilograms of ginned cotton. In 1913 the following plantations existed in the Amaramba Concelho:—

Soares Guedes & Co: 1,000 hectares of land granted, 225 hectares under cotton cultivation. This firm owns steam-driven machinery and warehouses.

Paes dos Santos: 1,000 hectares granted, 150 hectares under cultivation; steam-driven machinery.

Felismino da Fonseca: 100 hectares under cultivation.

Joaquim Baptista, Elias Vasilius, Regino Pietro: 50 hectares under cultivation each.

The production for 1913 was estimated at about 270 tons of clean cotton.

In the first months of 1913, the Administration of the Companhia do Nyassa received in Lisbon a large sample of cotton from Amaramba, an equal quantity being sent to the London Section. In Portugal the Company distributed this sample amongst various manufacturers in Lisbon and Oporto, one being sent to Professor Melo Geraldes, to whose special work we will hereafter refer more particularly. The manufacturers were unanimous in regarding the product as of excellent quality, some asserting that it would be specially suitable for manufactures of which the thread would be No. 40; generally they compared it with the quality "good middling" or even "fair middling fair," according to the Liverpool classification. One Oporto manufacturer compared it to Jumel cotton of Egypt. Mr. Henrique Taveira, a well-known manufacturer and director of the Companhia Fabril Lisbonense, wrote in highly flattering terms regarding Amaramba cotton, and having occasion to be present at the 9th International Cotton Congress, which took place at Schevening, The Hague, was good enough to take with him a sample of cotton. The opinion of the experts of the Congress were as follows: "Type Egyptian, colour good, staple irregular and a little weak, probable value in the Liverpool market 8½d. per lb., or 402 reis per kilo." At the same time Messrs. Wolstenholme and Holland, of Liverpool, reported as follows in regard to Amaramba cotton: "It is as good as any cotton from the east coast of Africa that we have seen." The 104 lb. of cotton sent to England were sold in London for £3 18s., i.e., 9d. per lb.

We should like to refer to the valuable services rendered by Prof. Geraldes. He carried out a minute and complete analysis and published his results in a paper entitled "A study of Cotton produced by the Companhia do Nyassa (Mozambique), carried out in the Laboratory of the Colonial Section of the Superior Institute of Agriculture in Lisbon." He states that the Amaramba cotton "appears to have its botanical origin in a variety of Egyptian cotton called Mitafifi. It has a good appearance, and would have a better one still if there were not mixed with it pieces of seed and bark. This defect can easily be corrected by more careful ginning and cleaning." As regards the irregularities in length of the staple and its strength, Prof. Geraldes indicated the probable causes of these, which indication should serve for future improvements in cultivation. (See Report of the Companhia do Nyassa to the General Meeting, 8th December, 1913.)

The following table shows the exportation of cotton in pod according to the Customs classification.

	1907	1908	1909	1910	1911	1912
Kilos ...	25,569 ...	26,920 ...	40,321 ...	43,652 ...	35,013 ...	35,527

We would add that the Customs statistics exceptionally mention in 1911 the exportation of 21,152 kilograms of cotton seed, certainly destined to assist the industrial transformation.

Fibres.

The baobab tree exists in almost all districts of the Territories and the natives extract the fibre, which is used for making strong, durable cords and fishing nets.

Sansevieria is also to be found in a natural state in the islands and also on the mainland. The natives extract the fibre by beating the leaves of the plant with a mallet, and gradually separating the fleshy part by means of scraping. They call it Namonge, and use it in the manufacture of cords and nets. (Governor Vilhena: *Reports and Memoirs*, page 398.)

Sisal hemp was introduced by Governor Vilhena into the Territories and distributed amongst various posts. It has been shown to flourish exceedingly well. There is a project to experiment with this culture on a large scale.

In view of the great demand for fibres for various industrial purposes, it is apparent that in this respect the Territories offer a large field for activity.

According to the Customs statistics the exportation of fibres described as "coconut fibres" was commenced in 1911, but native products, such as baskets and mats manufactured with these fibres, are exported in large quantities to other parts of the coast. The mats classified as superior from Tungue are of interesting designs, and are much appreciated. The fibres used for these manufactures are extracted from a species of palm tree of small proportions. (Governor Vilhena: *Reports and Memoirs*, page 328.)

Cereals and other foodstuffs.

The three principal cereals consumed by the natives in the Territories of the Companhia do Nyassa, and which they cultivate on a large scale, are maize, mexoeira, and rice. All these are exported, but it sometimes happens that rice is imported.

The cultivation of these cereals is dependent on the regularity and abundance of the rains, and as a result their exportation is very irregular, exportation being prohibited during years of scanty production in order to avoid famine.

Following the Customs classification, we distinguish round maize (mutama of the natives), *Sorghum vulgare*, flat maize (mafloeira of the natives), and Zea maize. The cultivation of these cereals is met with all over the Territories. (Governor Vilhena: *Report and Memoirs*, page 365).

In order to build up a remunerative export industry in maize cheap transport is necessary, not only from the localities of production to the coast, but thence to its destination. In many cases large quantities of maize are wasted in the interior, simply because it will not bear the cost of transport to the coast.

As regards the future of cultivation of maize Mr. Stocks writes: "The value of maize as an article of export to South African colonies has not apparently been properly recognised, except during the South African war. There appears to be great possibilities of a large export trade being done in this direction. For the past five years Cape Colony's imports have averaged 1,657,336 bushels per annum, of the value of over £250,000 yearly, chiefly from North and South America. Transvaal imports amounted to £196,894 and £156,475 in 1904 and 1905 respectively. Maize grows luxuriantly under native cultivation, and with the introduction of new varieties of seed the crops would show a considerable increase. The valley of the Rovuma would suit maize admirably; its culture is of the simplest, and in this case the native would need little teaching beyond the use of simple machinery." (Report to the Search Syndicate, 1907.)

The anticipations of 1907 as to the demand for this cereal, for South Africa, have been completely fulfilled, as is known.

Mexoeira (*Penicillaria spicata*=*Pennisetum typhoideum*) is cultivated on a much smaller scale than maize, and is also an article of export.

Rice is consumed by the natives of the Territories, and also by those inhabitants who come from India. It is principally cultivated in the lower and well-watered lands of the Tungue Concelho, which Mr. Stocks considers excellent for the cultivation of this product, as also land on the banks of the Msalu. Native cultivation of this is little developed, because native rice is not appreciated by the inhabitants of Indian origin. It is a fact that the statistics, while showing the export of this article to English possessions on the coast, also show its importation from India in much larger quantities. Thus, for example, in 1912, which was an exceptionally good year for exportation, 14,950 kilograms were exported, and 194,560 kilograms were imported. This further confirms the profit which would be derived from the cultivation on a large scale of a foodstuff the exportation and internal consumption of which are assured.

The exports of maize, mexoeira, and rice in the period 1907-1912 are shown in the following table.

Exports of Maize, Mexoeira and Rice (in Kilos).

Year	Fine maize	Flat maize	Mexoeira	Rice
1907	29,188	413,123	—	240
1908	949,228	1,527,133	121,915	1,438
1909	1,014,703	2,166,252	138,879	1,032
1910	644,981	1,495,932	19,956	1,500
1911	1,437,406	1,844,461	68,655	229
1912	—	1,719,108	99	14,950

As regards those vegetables which are cultivated on a large scale by the natives, we would only mention beans and mandioca, which are exported in considerable quantities, as is seen from the following figures:—

Exports of Beans and Mandioca (in Kilos).

Year	Beans	Mandioca
1907	244,635	1,485
1908	601,655	130,927
1909	302,904	32,688
1910	449,521	830
1911	129,828	236,823
1912	125,703	6,250

Tobacco.

Tobacco plants are found in a natural state, and are cultivated by the natives in almost all parts of the Territories, of which we might mention the Mahua district and the banks and islets in the river Lugenda, where the natives exercise a certain amount of care upon its cultivation, since it is a valuable article of barter. (Governor Vilhena: *Reports and Memoirs*, page 371.)

Judging from the extensive use of tobacco by the natives and its relatively important exportation, it can be estimated that its production is very large. "Native methods of preparing tobacco are of course very primitive, and might be much improved on. For this, the growing of good qualities of tobacco requires considerable skill to ascertain the varieties best suited to local conditions." (Mr. Stocks: Report to Search Syndicate, 1907.)

The general opinion is that African tobacco will never be able to compete with the more appreciated qualities from America and other parts of the world, and therefore efforts have not been exerted to introduce African tobaccos into Europe. It is possible that this point of view may not be absolutely correct, at least as far as tobaccos destined for employment in cheap products is concerned. In the meantime, in the Lake Concelho tobacco is already prepared by European processes, and is sent to England.

The following are the statistics of native tobacco exported from the Territories during the last six years:—

	Kilos
1907	18,216
1908	46,849
1909	50,986
1910	42,239
1911	91,306
1912	117,230

Coffee.

The coffee plant grows spontaneously in very diverse districts in the Territories of the Companhia do Nyassa, which has led an explorer to write that "The whole country might be a coffee plantation." All the coffee consumed in the Territories is of local production. That which is exported and known as Ibo coffee is grown on the coast and on the island of Ibo itself, but it appears that districts better suited for the cultivation of coffee are the valleys of the Ajaus mountains and the Upper Lugenda. Ibo coffee is similar to Mocca in appearance, but has a peculiar flavour, very agreeable to some palates.

"The coffee plant is born, grows, produces, and dies without anyone thinking of tending the soil, without its being cleaned or care taken that the plant may renew itself at the proper time. Not only is it not cultivated, but those that exist are not pulled up and the greater portion spring spontaneously from the soils suitable for their growth. When the berries are quite green and only just formed, the proprietor gathers them by shaking the trees or beating the branches with rods, and dries them, paying little attention to the quality they might possess if allowed to mature and become full grown. This is done in order to prevent theft by the natives. In the island of Ibo, where the property is easy to watch, the berry is only collected at the proper time, and is dried and roasted by proper methods; as a consequence the product is more savoury and superior in quality to any other in the Territories. Under these circumstances, in proper ground, between high coconut trees which give them very little shelter, or between acacias and wild apple trees that rob them of space, the coffee plants are found in almost all districts of the Territories on this side of the Lugenda. Its price varies according to the need the native has of money, and thus it is not difficult to meet negroes in the streets of Ibo, in Quissanga or on the coast offering it for sale at 150 or 200 reis per kilogram. Its ordinary price, however, is 300 reis when it is cleaned and well dried. The coffee 'Vista Alegre' of Ibo is the best in the Territories, and has been sold at 500 reis in years of poor crop." (Governor Pires Viegas: Bulletin No. 104.)

At the Exhibition of the Geographical Society of Lisbon of 1906, the Companhia do Nyassa exhibited 11 samples, which were awarded the Gold Medal Diploma. These samples all came from the Coast.

The exportation of coffee from the Territories during the last six years was as follows:—

	Kilos
1907	295
1908	50
1909	268
1910	316
1911	551
1912	1,226

The coffee was exported principally to the Province of Mozambique.

Coconuts and Copra.

The coconut palm is found in almost every part of the Territories, but it is principally found in the coastal district. "The whole coast line of the Bay of Mocimboa is a palm grove. Coconut trees grow plentifully in Mtamba, on Point Ullu, Revulu (not Levura), in Old Mocimboa, where they attain enormous dimensions. In general it might be said that the whole of the coast is suitable for cultivation of coconut trees, since a larger or smaller number of them is found in every settlement. If it were possible to count the number of coconut trees along the coast of the Territories, I think we should arrive at a number representing great wealth, because Ibo and Querimba are covered with them, and on all the other islands, such as Matemo, Macoloe and Quifula, where they are planted, they grow with great vigour and beauty; Mocimboa, Changane, Mucojo, Quirimize, Olumboa, Arimba are palm groves of the natives which give palm wine and coconuts." (Governor Vilhena: *Reports and Memoirs*, page 15.)

The variety of uses to which the coconut tree can be put is well known. The natives exploit it chiefly for palm wine, which is extracted from the sap, and for copra, of which there is a large export; the fibre we have already spoken of when treating of fibres.

The preparation of copra and its export were perhaps unknown, or at least in an elementary stage, at the time the Company took over the Territories.

Of all plantations the palm groves are perhaps those most cared for by the natives. They are an important factor in civilisation, as they constitute the most stable element in the permanent exercise of the right of ownership of the soil. The proprietors esteem and defend them before everything. With the increasing demand for copra the cultivation of coconut palms has appreciably developed in the Territories for several years past, not only by the native and half-caste proprietors but also by Europeans. The sub-concessions granted on the coast are almost exclusively used for the plantation and cultivation of coconuts, which is done by more approved methods than those adopted by the natives. The company now called Nyassa Plantations, Limited, has already planted on its concession at Ngochi, near Palma, 120,000 coconuts, whose ages vary from 1½ to 3 years. The soil of the palm groves is light sand. The rainfall during the year is about 45 in., principally from October to April.

The following table shows the exports of the three principal products of the coconut in recent years:—

Year	No. of coconuts	Copra Kilos	Fibre Kilos
1907	106	—	—
1908	9,205	—	—
1909	600	2,021	—
1910	5,375	13,977	—
1911	409	2,895	193
1912	9,005	32,627	2,295

Other Agricultural Products.

Amendoim is largely cultivated by the natives in almost all parts of the Territories, but chiefly in the Palma and Lurio Concelhos. It is cultivated at the beginning of the rainy season. The seed is exported in the husks because the oil soon becomes rancid when the seed is exposed to the air for any length of time. (Governor Vilhena: *Reports and Memoirs*, page 358).

Sesame, another plant producing an oil seed, which also serves as food for the natives, is equally cultivated by them on a large scale, and its oil is considered superior to that of amendoim.

The following statement shows the quantities of these two products exported during the last six years:—

Year	Amendoim Kilos	Sesame Kilos
1907	520.556	372,482
1908	870,320	1,128,714
1909	1,258,804	1,191,546
1910	989,797	627,342
1911	749,123	999,790
1912	760,777	1,309,291

The principal dye-yielding plants are argil and indigo. Both these are cultivated by the natives in small quantities for barter, the indigo being grown all over the Territories.

The sugar-cane appears to be met with spontaneously on the banks of some of the rivers of the Territories, and is cultivated by the natives solely for its food properties. The banks of the rivers, chiefly the Msalu and the Lugenda, and the low lying and humid land in the Tungue Concelho offer excellent facilities for the intensive cultivation of this product, not only because of the fertility of the soil, but because of the water facilities.

The castor-oil plant is abundant in the Territories, and in some localities becomes very dense. The natives collect the seeds for barter, and they are exported in large quantities.

Forest Products.

The forest products exploited include rubber (see p. 509), gum-copal, mangrove bark and timber.

Trees which produce gum-copal are very abundant in the forests, chiefly in the Maconde district, and on the banks of the river Msalu, and the natives extract large quantities of this product. The following is the exportation during the last six years:—

Year	Kilos
1907	34,016
1908	27.834
1909	41,842
1910	35,710
1911	31,495
1912	29,148

Mangroves occur in varying quantities along all the coast of the Territories, on the banks of the numerous rivers, and on the shores of the various creeks. In some districts they occur in great abundance. The bark, which is very rich in tannin, was not utilized by the natives, but as soon as the demand for it became considerable in

Europe, the small Indian traders commenced to apply themselves to this industry, employing natives for the stripping. To meet this growing demand unorganized stripping has been carried on, and various problems have presented themselves. Does the stripping of the bark kill the tree? If so, what is the method to avoid destruction? Or would it be preferable to allow the tree to die, and rely on its natural reproduction from its roots? Is it desirable to establish definite periods during which stripping is to be prohibited? These questions have not yet been settled, and require many years of patient study. In order to prevent destruction various administrative measures have been tried, such as payment of license tax, imposition of export duties and even prohibition of stripping and consequently of exportation during certain periods.

The decrease in the exports, statistics of which are given below, is the result not of a decrease in the demand, but of the endeavours made to prevent destruction of the trees.

Year	Kilos
1907	6,522,232
1908	748,606
1909	580,725
1910	135,955
1911	172,695
1912	211,179

Various timbers occur which are made use of by the natives for planks, rafters, beams, and small works of joinery. Of these, mention may be made of mogano (mahogany), pau preto (black wood), pau ferro (iron wood), and sandal wood. Some samples of these have been sent to Lisbon, and the statistics mention a certain exportation to Europe and Egypt, principally of black timber. All observers agree in saying that there is an abundance of these valuable woods. The Company has even received some proposals for its exploitation on a large scale, and for the use of these trees as railway sleepers. Up to the present, no concession in this respect has been granted, but everything proves that when the problem of transport has been solved the exploitation of the forests will be the object of extensive and profitable application of capital and activity.

L'ALTIPIANO DI BENGUELLA IN RAPPORTO ALLA COLONIZZAZIONE BIANCA.

Per il Professore Dino Taruffi.

Dei tre distretti, in cui viene distinta la colonia Portoghese di Angola nell'Affrica occidentale, quello intermedio di Benguella è indubbiamente il più importante.

Dalla costa procedendo verso l'interno, ne riesce evidente, la suddivisione in tre zone—le cosi dette regioni del Welwitsch—che si ripetono con analoghi caratteri anche nei rimanenti due distretti; zone distinte fra loro da diversa origine geologica e giacitura di terreni, da fauna e flora diverse, cioè:

1° la Zona costiera,

2° la Zona del cordone montagnoso,

3° la formazione dell'altipiano centrale.—

La *zona costiera* e formata da un succedersi di collinette, di altitudine non superiore ai 300-350 m., spesso con forti pendenze che, dal mare a guisa di fascia abbastanza regolare, si internano per una profondità di 40-50 km.

I terreni superficiali ed aridi, di aspetto brullo o ricoperti di vegetazione spinosa, che ne costituiscono le pendici, provengono da calcari del cretacco e del terziario.

Solo nelle gole e nelle erosioni dei fiumi e torrenti si trovano zone alluvionali piane, costituite da terreni spesso fortemente umiferi, agrariamente interessanti, ma di una estensione molto limitata.

Fra queste zone, la più importante per condizione di ubicazione, è la pianura formata dalle all'alluvione del Catumbella, che include i tre centri principali di popolazione bianca del distretto, cioè Lobito, Catumbella e Benguella.

Per salire sull'altipiano, attraverso le antiche strade carovaniere, occorre ascendere la *zona alpestre del cordone montagnoso,* costituita da rocce cristalline rivestite di vegetazione boschiva; Zona quanto mai pittoresca, ma di nessun interesse agricolo. Per mezzo di essa in breve cammino si raggiungono i 900-1,000 m. di altitudine e si giunge sull'orlo dell'altipiano.

L'altipiano si inizia con una serie di strette valli che, man mano inoltrandoci, si ampliano e si elevano. Successivamente, non si scorgono più catene montagnose, ma solo blocchi o picchi isolati che emergono per una altezza di poche diecine di metri a dominare lo stendersi delle blande pendici. Più internamente ancora, nel cuore dell'altipiano, che dai 1,500 m. arriva fino a circa 2,000 m. di altitudine, la serie delle Colline pianeggianti si allarga e si estende per tutta l'ampiezza dell'orizzonte.

Nella parte meno elevata od iniziale dell'altipiano, le pendici sono in generale riccamente coperte di vegetazione boschiva; quasi in contrapposto, nei culmini non rocciosi della parte più elevata, hanno predominio le pasture spogliate (caratteristica fra queste *l'anhara di Nbulo-vulo*); in fine, nella vasta plaga intermedia, il bosco occupa normalmente il dosso pianeggiante delle colline, mentre i fianchi lievemente pendenti lungo i ruscelli e le valli, sono pasturativi.

I terreni di questo altipiano provengono dal disfacimento in posto della roccia arcaica e specialmente del granito, al quale disgregamento ha concorso, nei fianchi e sul fondo delle valli, il trasporto dell acque. sovrapponendo un deposito più o meno ricco di materia organica.

La costituzione fisico-meccanica dei terreni che ne derivano è caratteristica: come resulta da 15 analisi, qui di seguito riassunte, ed eseguite dal Dott. Moreschini presso l'Istituto Agricolo Coloniale Italiano di Firenze, in relazione all'argilla e materie argilliformi, vi predomina fortemente la sabbia silicea e silicata. Infatti da un massimo di 236·029 per cento di argilla e sostanze argilliformi, si scende ad un minimo di 15·182 per cento.

Però questi terreni sono in generale assai ricchi di sostanze colloidi ed impastano facilmente con l'acqua: con mattoni crudi impastati vengono costruite comunemente le abitazioni dei Bianchi.

Chimicamente, sono poveri di calcare e contengono quantità varie di materia organica e di azoto; la proporzione di azoto, in generale superiore all'1 per cento, raggiunge nei campioni analizzati fino il 3·488 per cento. Sono ricchi di anidride fosforica e potassa, raggiungendo respettivamente proporzioni massime di 2·746 e 5·382 per cento, di fronte a minimi di 0·790 e 2·154 per cento.

Le cifre relative a ciascuno dei 15 campioni da me raccolti sono riportate nel prospetto qui unito.

Considerati dal lato industriale-agricolo, i terreni dell'altipiano di Benguella presentano varie condizioni favorevoli: per la loro giacitura a larghe pendici lievemente inclinate, possono permettere facilemente l'uso di mezzi aratori anche potentissimi ed a trazione meccanica; per il loro impasto, si lavorano con facilità e richiedono moderato sforzo di trazione; sono in generale molto profondi, offrendo così un ampio strato in cui le piante possono spingere le loro radici; si trovano in complesso in tale condizione che la riduzione a coltura vi è facile ed economica.

Nei reguardi del *clima* mancano ricerche meteorologiche estese ad una lunga serie regolare di anni, le quali permettano di esporre dati numerosi.

Le determinazioni saltuarie fatte nella Valle del Rio Cuiva e nella Regione di Huambo dal Dott. Pereira do Nascimento, quelle dell'agronomo Botelho e del Sig. A. d'Andrade, combinate con le osservazioni di persone residenti do anni nella regione, permettono di dedurre le caratteristiche seguenti.

Nell'altipiano di Benguella si alternano due stagioni perfettamente distinte:

1° La stagione delle piogge.

2° La stagione secca.

La stagione delle piogge comprende non meno di sette mesi, da Ottobre ad Aprile, e si divide in due periodi:

(1) Delle piccole piogge, che abbraccia in mesi di Ottobre e Novembre.

(2) Delle grandi piogge da Dicembre ad Aprile, con una sosta di 15 a 20 giorni in Gennaio: i mesi più piovosi sono Marzo ed Aprile.

SOPRA 1000 PARTI DI TERRA GREGGIA.

	Scheletro	Terra fina	Acqua igroscopica (a 110° C.)	Perdita a fuoco (sostanze organiche)	Calcare ($CaCO_3$)	Sabbia silicea e silicata	Argilla e materie argilliformi	Altre materie solubili in acidi all'1 per cento	Azoto totale (N).	Anidride fosforica totale (P_2O_5)	Potassa totale (K_2O)
1. Fazenda sequiribir = terreno a pastura	209·854	791·146	41·268	53·244	2·294	618·755	25·712	19·383	1·582	2·294	3·797
2. Fazenda sequiribir = terreno lavorato	63·178	936·822	23·233	60·425	1·873	796·767	52·301	2·343	1·719	1·592	2·154
3. Fazenda cibulla = precedentemente ,, a batata = terreno a pastura	0·827	999·173	74·599	73·986	1·099	713·409	107·011	2·897	2·497	1·398	3·497
4. ,, ,, ,, = terreno lavorato	318·090	681·910	1·452	43·642	3·078	573·145	40·637	7·091	1·432	1·022	2·864
5. Vallata di Luimballe	7·300	992·700	10·754	24·023	1·805	650·714	212·139	93·314	3·070	0·790	3·470
6. Missione dei Gesuiti di Bailundo Terreno del podere	2·000	998·000	42·315	36·027	0·998	823·841	64·963	30·838	1·596	0·798	2·395
7. Canduco presso Bailundo terra di bosco	114·037	885·963	2·212	3·009	3·274	789·103	26·224	22·237	1·328	2·746	2·835
8. Fazenda Tenente = prelevato in sommità di colle, coltivato a batata	206·250	793·750	21·510	76·453	4·286	430·530	236·029	32·940	0·710	1·650	3·410
9. Fazenda Tenente = terreno a maggese già coltivato a batata ...	211·562	788·430	48·015	41·574	6·070	616·558	48·173	2·699	1·024	1·576	4·809
10. Fazenda Tenente = terreno di valle coltivato a mais e fagioli ...	0·125	999·875	36·967	48·539	1·199	801·499	98·287	1·249	1·899	0·899	4·299
11. Fazenda Gandarinha pastura già coltivata a batata	52·083	998·917	96·195	80·512	1·698	650·790	129·659	4·004	0·799	1·598	3·396
12. Fazenda Ceriena = terreno a pascolo	1·227	998·773	21·005	23·297	0·998	839·169	62·247	7·570	2·496	0·898	2·297
13. ,, Cabir = pascolo già seminato	101·123	898·877	2·898	79·175	18·876	573·393	15·182	7·280	1·348	0·833	4·943
14. Terreno di pascolo nello scavo accanto alla Casa Commerciale D'ormellas a Cahnia	3·076	996·924	37·701	68·552	0·378	808·505	78·750	20·935	1·496	1·796	4·087
15. Anhara di Bihèle = pastura ...	3·250	996·750	70·360	91·003	2·491	798·004	40·468	4·485	3·488	2·093	5·382

Le pioggie sono in generale abbondanti, precedute da grandi tuoni ed accompagnate da forti scariche elettriche; durano di regola un'ora o poco più e subito il cielo si rasserena; raramente piove più ore di seguito.

La quantità annuale di pioggia è elevatissima: le determinazioni eseguite la fanno ritenere oscillante fra i 1,300 mm. ed i 1,700 mm. ed oltre. Anche in anni scarsissimi, sembra non si abbassi mai sotto i 1,000 mm. L'umidità media si considera del 72 per cento nella zona più alta (oltre i 1,500 m. d'altitudine) e dell'80 per cento nella zona più bassa.

La temperatura diurna, durante questo periodo, non sale di regola sopra i 30°-32° C., nè si abbassa durante la notte al di sotto di 16°-14° C.

La *stagione secca* si estende ordinariamente da Maggio a Settembre.

La temperatura diminuisce gradatamente da Maggio a Giugno per risalire di seguito. Durante la notte si possono raggiungere, dei minimi di 40° C. (raramente si scende a 0° sui margini dei rii e nel fondo delle valli); ma durante il giorno la temperatura risale fino a massimi di 24°-26° C.

In questo periodo, il cielo è sempre limpido e l'atmosfera secca; rare sono le nebbie, ma si hanno (specialmente in alcuni mesi dell'anno) rugade abbondante (cassimbo).

In relazione con queste condizioni di clima, l'altipiano, particolarmente nella sua zona centrale inoltre i 1,500 m. d'altitudine, va esente da fenomeni di paludismo e si mostra immune da malattie tropicali, ed i Bianchi che da vari anni lo abitano per esercitarvi il commercio, sono testimoni delle sue buone condizionidi salubrità.

L'abbondante caduta di acque che avviene durante un periodo di circa 7 mesi, la natura del suolo filtrante è quella della roccia arcaica, sono circostanze determinanti favorevoli *condizioni idrografiche*.

In conseguenza di tali circostanze, sull'altipiano, se mancano o sono rare le grandi sorgenti proprie dei terreni calcarei, è abbondantissimo però quello stollicidio di acque sui fianchi dei monti e dei colli, caratteristico dei terreni arcaici.

Basta esaminare una carta corografica dell'altipiano (tenendo presente che alcune regioni non sono ancora geograficamente ben studiate) per formarci un idea di quanto sia sviluppata l'idrografia della regione.

Infatti, nell'altipiano di Benguella spingono le loro radici molti fra i maggiori fiumi dell'Affrica meridionale.

Per limitarci ai principalissimi, girando attorno alla linea culminante che si può considerare fra Huambo e la anhara di Nbulo-vulo, si incontrano i bacini del fiume Catumbella, del fiume Queve degli affluenti di sinistra del Cuanza, del Cutato dal Ganguellas, del Cunene: si tratta di fiumi tutti di primaria importanza, che scendono al mare con acque perenni di parecchi mc. di portata a m." anche in tempo di magra.

In conseguenza delle condizioni idrografiche e della inclinazione che naturalmente hanno i terreni, l'alti piano presenta la possibilità di numerose e freguenti—se non molto importanti ciascuna—utilizzazzioni di acque, per irrigazione o per forza motrice.

Sull'altipiano vive una popolazione indigena assai numerosa, di razza bantù con infiltrazioni varie, completamente pacificata, mancante di spirito guerresco.

Sulla base dei dati di vari exploratori che hanno percorso la ragione, si calcola che l'Angola abbia una popolazione indigena media di 6 abitanti a km. q.; ma, se si considera che il distretto di Benguella è il più popolato e che gli indigeni sono concetrati specialmente sull'altipiano, bisogna ammettere che quivi la densità supera di gran lunga la media.

Questa popolazione, che oggi fornisce i *portatori* al commercio dei Bianchi, potrà in un prossimo avvenire fornire la mano d'opera occorrente alle aziende agricole: d'atronde è notorio che questo distretto forniva, specialmente qualche anno indietro, abbondante mano d'opera alle "Rochas" di S. Thomé e di Principe.

Fra gli indigeni, mentre gli uomini sono in prevalenza portatori e commercianti, le donne ed i ragazzi sono debiti all'agricoltura. Le colture ordinariamente seguite dagli indigeni sono: granturco fagiuoli, patata, patata dolce; in proporzione minore, sono coltivati anche il caffè, il riso, il cotone, il tabacco, la canna saccarina; cucurbitacee varie e varie piante della flora indigena.

Per altro, il granturco, ed i fagiuoli costituiscono la base della alimentazione dei neri.

I Bianchi, che attualmente vivono sparsi sull'Altipiano, per esercitare il commercio ed accaparrarvi il, caucciù la gomma e gli altri prodotti che vengono dall'interno, raramente esercitano della vera e propria agricoltura.

Nei loro orti si trova coltivato però ogni sorta di ortaggio, cavoli, insalate, pomodori, cipolle, fragole, ecc.; nei loro campi si vedono introdotte le colture di grano, di avena, di fave, di piselli. Svariatissime sono piante fruttifere da loro introdotte, ma straordinariamente produttive fra le altre sono gli agrumi, i peschi, i nespoli del Giappone, i gelsi.

Tutto ciò dimostra l'adattabilità dell'altipiano a piante diverse, erbacee e legnose; dimostra la possibilità di esercitare quella coltura mista, che offre alimenti svariati ai coltivatori, che aumenta le ragioni di provento e rende più costante il reddito delle imprese agricole.

Rispetto al bestiame, vivono sull'altipiano numerosi bovini, ovini, suini; si tratta di animali oggi a limitate attitudini, ma che potrebbero ben costituire la base di un importante allevamento avvenire.

Dalle notizie sommariamente esposte, si può redurre con fondata regione che l'altipiano del Benguella presenta in se condizioni favorevoli al proficuo sviluppo dell'industria agricola e zootecnica; e, dato il clima e la salubrità del paese, si può giustamente dedurre che queste potranno indifferentemente esercitarsi in aziende ad ordinamento industriale—agricolo con mano d'opera indigena, o mediante piccole aziende esercitate direttamente dai Bianchi.

Le favorevoli condizioni accennate, fino a pochi mesi or sono, esistevano sull'altipiano del Benguella solo allo stato potenziale. Chi infatti avesse voluto allora trasportare alla costa, attraverso al massiccio granitivo, i prodotti del suolo, avrebbe dovuto necessariamente valersi dell'opera dei caricatori indigeni, o di carri Boeri, mezzi gli uni e gli altri, lenti e molto costosi.

Oggi un fatto nuovo è intervenuto a valorizzare l'altipiano. Da Lobito parte un tronco ferroviario, che attraverso l'altipiano centrale, per Ruwe arriverà a Kambove nel Katanga, allacciandosi con la Ferrovia del Congo; di quì, per Elisabethville, mediante il nuovo tratto di congiungimento fra la Rhodesia e il Katanga, sarà unito con Bulawayo e quindi, da un lato con Beira, dall'altro col Capo di Buona Speranza.

Una attività nuova si và manifestando per sviluppare i mezzi di accesso: ai vecchi sentieri, percorsi soltanto dai caricatori, si stanno sostituendo le strade che, sebbene di costruzione economica, migliorano gia sentitalmente le condizioni del traffico. Facilitati gli accessi, la valorizzazzione agricola dell'altipiano di Benguella, si deve considerare avvenimento a breve scadenza.

THE PROGRESS OF NATIVE AGRICULTURE IN CEYLON.

By C. Drieberg, B.A., F.H.A.S.

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In this paper the term "Native Agriculture" is used to indicate the cultivation of crops other than those generally spoken of as "Planting Products" comprising mainly tea, cocoa and rubber.

Till within recent times and subsequent to the fall of the great coffee industry, coconut cultivation was mainly in the hands of the Cingalese, but with the rise of the coconut industry much European capital has been invested in this enterprise, which has now attained an important position in tropical agriculture.

Conversely a small proportion of the Cingalese population has joined the ranks of tea, cocoa and rubber planters.

But for the purposes of this paper, tea, cocoa and coconuts, as estate products, will be left out of consideration, and attention given only to such crops as are entirely in the hands of the Cingalese. The chief among the latter is rice or, as it is locally called, paddy, which is the term applied to rice in the husk.

It would be out of place in this paper to give a detailed account of paddy cultivation as practised in Ceylon. Suffice it to say that the crop has not attained to the importance of an export product, and that there is still a large importation of grain into the island chiefly from Peninsular India and Burma.

Whether the island will ever produce enough rice to meet the demand not only of its permanent population but also that of the large floating population of Indian labourers who work on tea and rubber estates is very doubtful, but there is no doubt that it could be extended so as to add appreciably to the available food supply.

The main direction in which such extension is possible is in the tank districts of the Northern, North Central and Eastern Provinces, where large areas which in Cingalese times were under cultivation await the return of the paddy farmer. With the repair and reconstruction of tanks, the conditions for a revival of agriculture in these parts are steadily improving; while the enterprise of the Mohammedan population, the likely ingress of the South Tamil cultivator as a result of direct railway communication with India, and the awakening national pride of the Cingalese people are factors which may be relied on to assist in the development of native agriculture, urged by the exigencies of a growing population and the competition which is bound to result therefrom.

Quite recently a new factor has arisen in the alleged "losses" on estates worked with Tamil labour, by the rise in the price of imported rice; and European capitalists are seriously considering the question of embarking upon paddy cultivation on an extensive scale in order to meet the difficulty. The enterprise is a fascinating one, but whether it will prove a commercial success it is impossible to prophesy as there are so many details that have to be reckoned with which can only be fully understood when met with in practice.

The yield of paddy except in certain limited areas is much below what it should be, not so much owing to want of effort to improve it but owing to the conservative character of the cultivator in clinging to time-worn practices.

It is encouraging, however, to note that the paddy cultivator is coming to recognize the necessity for changing his methods—this result being brought about chiefly through the work of the Ceylon Agricultural Society during the past ten years. Through its staff of agricultural instructors who act the part of missioners among the agricultural masses, the Society has been successful in exercising an appreciable influence on the cultivator. These instructors, who are in close touch with the village population and understand their needs, have come to win their confidence, and in this way to induce them to accept advice and assistance whenever offered. The means by which better results are brought about are (1) by the employment of improved types of implements, (2) by the introduction of the transplanting system (i.e., planting out seedlings from nursery) and (3) by the employment of green manures for fertilizing the land.

Native agriculture in Ceylon may roughly be divided into (*a*) wet cultivation and (*b*) dry cultivation. By the latter is not meant the so-called modern system of "dry farming," but the cultivation of dry as opposed to wet land. Paddy is essentially a wet crop inasmuch as it is grown under wet conditions, i.e., under tank irrigation or on the low lands on which the rain water is conserved, i.e., retained by means of bunds or ridges to meet the requirements of paddy as a water-loving plant.

There are, of course, certain varieties of rice which grow under comparatively dry conditions, which would appropriately come to be considered under dry cultivation.

Dry cultivation is generally associated with what is known as the "chena" system which is found to exist in all undeveloped countries and is in vogue in the drier parts of the island where tank irrigation is not available. The chena may be described as a tract reclaimed from jungle and generally cultivated for a single season, after which it is abandoned for a term which may extend up to ten years before it is again taken up, while in the meantime the cultivator moves on to successive fresh tracts.

It would be out of place here to discuss the merits or demerits of this system which can only be done with a thorough understanding of all the disabilities which the chena cultivator suffers; but it is obvious that the adoption of a provident system of cultivation, if it were possible, would be to the mutual advantage of the cultivator as well as the State as landlord, since the land on which the former operates is the property of the Crown and is rented to him.

It may be here stated that the policy of Government is to discourage chena cultivation and to substitute for it a more rational system of agriculture. To assist in this the Agricultural Society has devised a modification of the rotation system to meet the special case of the chena cultivator. This system advocates the division of the chena tract into two, three, or four sections (according to prevailing conditions) each carrying a different crop at one and the same season, and one crop succeeding the other in regular succession. The following instances will make this clearer:—

A.—*Modification of a four-course rotation.*

	(1)		(2)		(3)		(4)
(*a*)	Cotton	...	Legume	...	Grain	...	Manioc
(*b*)	Legume	...	Grain	...	Manioc	...	Cotton
(*c*)	Grain	...	Manioc	...	Cotton	...	Legume
(*d*)	Manioc	...	Cotton	...	Legume	...	Grain

B.—*Modification of a three-course rotation.*

	(1)		(2)		(3)		(4)
(*a*)	Grain	...	Cotton	...	Legume	...	Grain
(*b*)	Cotton	...	Legume	...	Grain	...	Cotton
(*c*)	Legume	...	Grain	...	Cotton	...	Legume

In its simplest form the rotation would consist of grain and legume grown alternately on two sections of the chena tract. The grain may be hill paddy or any of the millets, the legume one of the many forms of tropical beans. Manioc as a root crop may be replaced by sweet potatoes or yams. Cotton is the only non-edible crop which it is sought to popularize.

The chief requirement of the chena cultivator is an edible crop, and it is to his advantage to have his diet varied as much as possible. As a rule he practically grows nothing but millets, a continuous diet of which is by no means the best ration.

Through the instrumentality of the agricultural instructors this innovation in chena cultivation is slowly gaining ground.

Apart from chena cultivation proper, there are certain crops which are grown under dry conditions, the chief of which is tobacco. The cultivation of tobacco is an old industry which is mainly in the hands of the Tamils of the North, but within the last 25 years the cultivation has spread to most dry districts in the Eastern, North Western, Central and Southern Provinces. The bulk of the tobacco cultivated is of a coarse type only suitable for consumption in the East. In the Dumbara District of the Central Province, however, a variety of tobacco originally introduced from Cuba by a European planter, has become naturalized and produces a leaf that is better suited to Western requirements. The cultivation of this tobacco has been greatly encouraged by the intervention of a local German firm who have erected a curing shed in the district with a view to preparing tobacco for the European market. The enterprise has been promising so far and its extension would be of considerable benefit to the permanent population.

Cotton is a crop that has not responded well to the efforts that have been bestowed upon it. So far there is no extensive area under this product, and as far as experimental cultivation has been able to show the Hambantota District in the south-east of the island is well suited to the crop, while parts of the Northern and Eastern Provinces are also likely to grow it successfully.

The cultivation of vegetables gives occupation to many cultivators chiefly in the vicinity of towns, the higher elevations growing introduced varieties and the lowlands producing the different tropical kinds including yams (Dioscoreas). In this connection mention should be made of the useful part played by the school garden in introducing new varieties of vegetables (new to the island as well as to special localities) and thus adding to the food supply of the people. Indeed the popularity of vegetable growing has appreciably increased through this means. Through the school gardens also, of which there are 270 in the island, the younger generation of the village population are coming under a system of education which better fits them for a rural life and makes them take a more intelligent interest in their surroundings, so that they may be expected to develop into better agriculturists.

I do not touch upon fruit culture, which is the subject of a paper by Mr. H. F. Macmillan, F.L.S., the Superintendent of Botanic Gardens, Ceylon (p. 634).

Within the past year the island has happily seen a long-deferred Department of Agriculture an accomplished fact. The work so long done by the Agricultural Society is now passing into the hands of the Department, and the future of native agriculture in Ceylon is more hopeful than ever.

THE PROSPECTS OF DRY FARMING IN CEYLON.

By C. DRIEBERG, B.A., F.H.A.S.,

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COMPARED with the so-called dry regions of the rest of the world the dry areas in the tropics are well served as regards rainfall, but the characteristic of the "monsoons" prevailing in the latter is that they precipitate their moisture within a limited period with the result that long intervals of rainless weather make it a difficult matter to maintain the healthy growth of crops during such seasons.

The mean annual rainfall of Ceylon varies from 30 or 40 in. to 200 in. The south-west monsoon rains which prevail from April to July mainly serve the south-west of the island, while those of the north-east monsoon, lasting from October to January, are more evenly distributed.

The driest areas are found in the north-east and south-west, comprising the Puttalam, Mannar, Jaffna, and Hambantota Districts. In these the rainfall is below 50 in. per annum.

The next driest areas, in which the rainfall is between 50 and 75 in. per annum, are much wider and include the Chilaw, Anuradhapura, Trincomalee, Batticaloa and part of the Matara Districts.

The dry zones form two-thirds of the total area of the island, most of which is still in jungle. Here cultivated perennial crops such as rubber, tea and cocoa, all of which need a liberal rainfall, have no chance of thriving. Coconuts, on the other hand can be grown under dry farming conditions. On the Dry Zone Experiment Station at Mahailluppalama in the North Central Province, managed by the Department of Agriculture, it has been conclusively proved that with a proper system of tillage the coconut palm can be made to grow well and yield good crops. Unfortunately this station is difficult of access and has been visited by comparatively few of those who are likely to be benefited by learning first-hand the lesson it teaches. But it has not been without its influence on the coconut industry of the island through the attention it has directed to the advantages of tilling on dry farming lines. Through the exertions of the Director of Agriculture a more accessible dry zone station is being opened an Anuradhapura, which is on the railway, while a coconut trial ground for the Chilaw-Puttalam District is also about to be established. The more intelligent coconut planters are already adopting improved methods of cultivation encouraged by the better price of nuts that has recently ruled the market.

In travelling through the Chilaw-Puttalam District during the dry season one cannot but be struck with the difference in the appearance of the palms on hard-baked, grass-covered estates on the one hand, and loose soil-mulched lands on the other. On the former one sees drooping withered fronds, on the latter healthy spreading foliage, indicating as clearly as does the garden balsam, the flaccid and turgid condition of the plant cells under dry and moist conditions.

It has recently been stated that the area available for coconut cultivation in Ceylon has almost reached its limit, but it may be anticipated that under up-to-date management the dry tracts that have so long lain idle as being unsuitable for coconuts will before long come under cultivation; and indeed one is led to believe that the palm may suffer more from too great than from too small a rainfall. Extensive tracts of Crown land in the dry zone are now being offered for sale and find ready purchasers.

Attention has recently been directed to the possibility of growing the African oil palm and Sisal hemp in the driest portions of the island.

For the small cultivator who favours annual crops much remains to be done in the way of demonstrating the possibilities of raising suitable products in districts with a scanty and badly distributed rainfall and served in most cases only by the north-east monsoon.

The Cingalese villager appears to have an inherent belief that the chief requirement of cultivated crops is a copious supply of water. In paddy cultivation it is generally admitted that he uses much more water than is necessary. In favoured districts he is free to act upon this belief with the facilities which a liberal rainfall, a convenient spring or stream or a shallow well affords him. In the drier parts he depends upon tank channels for the water supply. When his lot is cast in places where such facilities are absent he strictly limits his cultivation to the rainy season. He has little knowledge or experience of how to conserve soil-moisture by means of tillage as the Tamils of Southern India and Northern Ceylon do. Happily this condition of things is slowly undergoing a change through the teachings of the Agricultural Society's Instructors, and the example set in school gardens. On the Agricultural Department's new Dry Zone Experiment Station a series of demonstrations in the growing of annual crops on dry farming lines will form part of the programme of work, and should serve as a useful object lesson.

There is a notion prevalent that it will be possible to apply the principles of dry farming to paddy, but this is not to be encouraged for obvious reasons, though it may be possible to grow certain races of hill-paddy, which are generally raised without irrigation, by this means. But there are many other crops suitable for the purpose. Among cereals we have maize, sorghum and the smaller millets (Setaria, Paspalum, Panicum, etc.); among legumes, species of Dolichos, Phaseolus, Cajanus, Vigna, Arachis, etc.; among oil plants, Sesamum, Guizotia, Ricinus, etc.; among fibres, Crotalaria, Hibiscus, Sansevieria, etc. There are besides such important products as tobacco and cotton, and a long list of "curry-stuffs," e.g., chillies, coriander, cumin, etc., which are imported into the island in enormous quantities, all of which are suitable for dry cultivation.

It is not unlikely that with a railway connection between India and Ceylon the cultivators of the Deccan may be attracted to the lands in the north-east of the island and lead the way for their colonization. The foundation for such colonization may be said to have been laid by the opening of railways to the north and the north-west of the island to facilitate travel and transport. So far, however, the vast jungle tract lying between the Jaffna peninsula and Anuradhapura known as the " Wanni " has hardly been touched.

It must be admitted that there are elements which are calculated to repel rather than attract the settler, e.g., the want of a convenient water supply, the prevalence of malaria and the presence of wild beasts; but these difficulties must recede before the march of civilization and science.

It would be fortunate for the Colony if a financially sound body of men led the way in a project for which capital and enterprise backed up by experience of dry-farming methods are the chief desiderata. It was indeed adventure of this nature which brought about the development of the great planting industries, first coffee, then tea and lastly rubber in the wet hill country which was at one time as inaccessible and difficult for the colonist to live in as the jungles of the dry low country. Once the pioneer succeeds in gaining a footing it may be expected that others will follow in his wake, and the time hastened when our arid tracts will support a thriving industry fostered by the "new agriculture."

PRESENTATION DES STATISTIQUES DU COMMERCE DES COLONIES FRANÇAISES.

Apercu statistique du Mouvement d'Exportation des principaux Produits des Colonies françaises pendant la Période décennale 1904-1913.

Par Ch. Vergnes.

Gouverneur des Colonies, Directeur de l'Office Colonial, Paris.

J'ai l'honneur de déposer sur le Bureau du 3e Congrès International d'Agronomie coloniale et tropicale, au nom de l'Office Colonial du Ministère des Colonies, les Statistiques du Commerce des Colonies françaises pendant les années 1907 à 1911. Je me propose de compléter cette collection au fur et à mesure de la publication des volumes qui sont annuellement édités.

J'ai pensé qu'il convenait d'extraire de ces Statistiques, toujours arides, un aperçu du mouvement des principaux produits d'origine végétale, produits qui intéressent plus particulièrement le Congrès, et d'en faire l'objet d'une communication spéciale. Il sera possible ainsi de mettre en relief les progrès, dans les Colonies françaises, aussi bien de l'agriculture que de l'exploitation des produits naturels du sol, en remontant à une époque un peu plus éloignée que la dernière période quinquennale et en tenant compte des résultats de 1912 et 1913 qui, connus à ce jour, n'ont pu être jusqu'à présent qu'en partie publiés.

Il fallait se borner cependant dans cette rapide étude; aussi n'ai-je pas voulu remonter plus loin que la dernière période décennale 1904-1913; et je n'ai envisagé que les produits d'origine végétale—produits qui, il faut le retenir, constituent 71 pour cent de l'exportation totale de nos Colonies—et parmi ces produits ceux qui présentent le plus d'importance pour des causes diverses.

Les uns, comme les bois, les arachides, sont importants par le rang qu'ils occupent dans l'ensemble de la production des Colonies françaises, aussi bien en quantité qu'en valeur.

Les autres tirent leur importance non plus du tonnage de la production, mais plutôt de leur valeur intrinsèque.

Il en est d'autres enfin qui sont intéressants par la place qu'ils occupent dans l'échelle de la production mondiale comparée.

Ne retenant ainsi que les plus remarquables à ces divers titres, j'ai limité mon examen aux produits suivants :

Les Arachides.

Le Coprah.

Les Huiles de Palme et les Amandes de Palme.

Les Bois.

Le Caoutchouc.

Le Sucre.

Le Riz.

La Manioc.

Le Café.

La Cacao.

Le Thé.

La Vanille.

Le Poivre.

Je n'ai pas eu la pensée de donner au Congrès une idée complète du développement de la culture, de la production et de l'exportation de chacun de ces produits; cette recherche m'eût entraîné trop loin et m'eût obligé à sortir du cadre déterminé par les règlements constitutifs de l'Office Colonial que je représente ici. D'ailleurs si nous possédons des documents suffisamment exacts et précis sur les quantités et valeurs livrées à la consommation extérieure et qui font l'objet de l'exportation, il n'en est pas de même des documents relatifs à l'étendue des cultures et à la production réelle de chaque produit dans chaque colonie.

Il eut été possible, pour certaines denrées, le riz par exemple, de donner la superficie approximative des terrains consacrés à la riziculture en Indochine, à Madagascar; il eût même été possible, quoique avec moins d'approximation, de donner soit directement, soit par déduction, un chiffre de la production totale, comprenant à la fois le chiffre de la consommation locale et celui de l'exportation; il n'en était pas de même pour les produits qui ne font pas uniquement l'objet d'une culture rationnelle et sont aussi des produits naturels du sol, soit méthodiquement exploités, soit même librement recueillis, tels les caoutchouc, les bois et les palmistes.

Aussi, laissant de côté la culture, n'ai-je voulu m'occuper que de la production, et même de cette partie de la production qui sort de nos colonies pour être livrée à la consommation extérieure.

Au surplus, si le chiffre de l'exportation est de beaucoup inférieur à celui de la production pour certains des produits envisagés (riz, thé, manioc, oléagineux, etc.), il s'en rapproche beaucoup pour d'autres, tels que la vanille, le poivre, le caoutchouc, etc. La consommation locale de ces derniers produits est faible, insignifiante pour ainsi dire, et l'on peut admettre en ce qui les concerne que le chiffre de l'exportation correspond à peu de chose près au chiffre de la production.

Chaque produit examiné fait l'objet de graphiques donnant en quantité et en valeur la courbe de l'ensemble de l'exportation des Colonies françaises pendant la période décennale 1904-1913 et celles de l'exportation particulière à chacune des Colonies dont la part est la plus forte dans cet ensemble. La courbe d'ensemble exprime donc le total de l'exportation de l'empire colonial français et non pas seulement la somme des courbes particulières à chacune des colonies dénommées.

Les graphiques sont accompagnés de notes explicatives sommaires, donnant les chiffres précis et faisant ressortir quelques détails que les courbes ne pouvaient rendre.

Les Arachides.

L'exportation des arachides provenant de la production des Colonies françaises pendant la période décennale 1904-1913 s'est élevée aux chiffres suivants:

Années	Quantités Tonnes	Valeurs Francs
1904	138 225	21,384,240
1905	96,324	14,873,343
1906	101,[illegible]78	25,0[illegible]7,92[illegible]
1907	155.908	30,897.243
1908	146,038	33,130,[illegible]80
1909	228 317	44,340,512
1910	231,747	50,361,836
1911	170,453	42,952.386
1912	198,880	43.581,187
1913	150,935	61,504,171

D'après les résultats de 1913 (année moyenne) les colonies productrices se classent de la manière suivante:

Colonies	Quantités Tonnes	Valeurs Francs
Sénégal	140,436	59,337,320
Guinée	3,541	553,727
Indochine	630	94,534
Haut Sénégal-Niger...	6,326	1,518,465

Le chiffre de l'exportation, qui était de 152,000 tonnes d'une valeur de 35 millions de francs en 1903 (année moyenne), s'est élevé à 151,000 tonnes d'une valeur de 61 millions de francs en 1913 (année moyenne).

La production des arachides est sujette à des fluctuations importantes aussi bien en quantités qu'en valeurs. Le maximum de l'exportation pendant la période envisagée a été en 1910 avec 232,000 tonnes d'une valeur de 50 millions de francs; le minimum a été en 1905 avec 96,000 tonnes d'une valeur de 15 millions de francs.

La consommation locale des arachides est très importante, mais il serait difficile avec les documents dont nous disposons de l'évaluer.

Les arachides sont presque uniquement expédiées en cosses; l'industrie de l'huile ne s'est pas développée.

Il est à prévoir que la culture de ce produit se développera prochainement dans des proportions considérables, à la suite de l'ouverture des voies ferrées en construction ou en projet en Afrique Occidentale Française et en Afrique Equatoriale Française.

Le Coprah.

L'exportation du coprah pendant la dernière période décennale 1903-1912 s'est élevée aux chiffres suivants:

Années	Quantités Tonnes	Valeurs Francs
1903	14,911	3.866 917
1904	9 765	2,839.483
1905	11,220	2,918,111
1906	8,373	2,740,383
1907	7,984	2,576 093
1908	10,776	2 8[illegible]9,901
1909	16,377	5 2 8.258
1910	17,584	6,360,706
1911	17,526	6.536.682
1912	16,266	6,3[illegible]6,765

Les Colonies productrices se classent dans l'ordre suivant d'après les résultats de l'année 1912 (année moyenne).

Colonies	Quantités Tonnes	Valeurs Francs
Et. de l'Océanie	5,979	2,809,223
Indochine	7,978	2,393,685
Nouvelle-Calédonie	1,947	98[illegible],132
Dahomey...	300	105,263
Côte d'Ivoire	21	6,520

L'exportation avait été de 14,911 tonnes d'une valeur de 3,870,000 francs en 1903 (année faible); elle s'est élevée en 1912 (bonne année) à 16,266 tonnes d'une valeur de 6,317,000 francs.

La noix de coco à l'était frais et le coprah font en outre l'objet d'une consommation locale importante.

Huile de Palmes et Amandes de Palmes.

La production du palmier à huile comprend l'huile de palmes d'une part, les amandes de palmes d'autre part.

Le tableau ci-dessous fait ressortir les chiffres de l'exportation de ces deux produits en quantités et en valeurs pendant les dix dernières années 1904-1913.

Huiles de Palmes.

Années	Quantités Tonnes	Valeurs Francs
1904	14.434	6,325,751
1905	9,112	3,627,524
1906	11,112	4.50 ,6 2
1907	13,709	5.461.971
1908	15 342	7,724,774
1909	22.944	9.381,587
1910	20,769	9,145,293
1911	22,001	12.221,194
1912	18,911	10 215,778
1913	14,682	7,307,780

Amandes de Palmes.

Années		Quantités Tonnes		Valeurs Francs
1904	... ...	33,812	... ...	6,919,287
1905	... ...	25,029	... ...	5,361,630
1906	... ...	26,460	... ...	5,671,708
1907	... ...	27,731	... ...	6,413,967
1908	... ...	32,741	... ...	7,752,150
1909	... ...	43,744	... ...	10,357,799
1910	... ...	46,809	... ...	12,583,999
1911	... ...	51,747	... ...	15,852,550
1912	... ...	51,377	... ...	16,959,278
1913	... ...	41,066	... ...	15,409,016

D'après les résultats de 1912 nos Colonies productrices peuvent être classées comme suit pour les huiles de palme :

Colonies		Quantités Tonnes		Valeurs Francs
Dahomey	... ...	11,917	...	6,361,320
Côte d'Ivoire ...	... ...	6,776	...	3,727,065
Guinée	... ...	142	...	84,922
Gabon ...	... ...	49	...	27,322

Le classement est le sûivant pour les amandes de palmes :—

Colonies		Quantités Tonnes		Valeurs Francs
Dahomey	... ...	37,495	...	13,398,416
Côte d'Ivoire ...	... ...	6,799	...	1,707,753
Guinée	... ...	5,135	...	1,026,969
Sénégal	... ...	1,764	...	705,514
Gabon ...	... ...	92	...	29,837

Il existe en Afrique Occidentale Française et en Afrique Equatoriale Française de très abondants peuplements de palmiers à huile (*Elaeis guineensis*) exploités rationnellement ou d'une manière rudimentaire par les indigènes.

Spécialement au Dahomey et à la Côte d'Ivoire le palmier à huile est l'objet de soins culturaux.

L'exportation qui était de 14,400 tonnes d'une valeur de 6,326,000 francs en 1904 est passée à 18,911 tonnes d'une valeur de 10,216,000 francs en 1912 (année moyenne) et à 14,700 tonnes d'une valeur de 7,308,000 francs en 1913, année déficitaire.

Les Bois.

L'exploitation des bois dans les Colonies françaises pendant les dix dernières années a donné les résultats suivants, constatés à la sortie :

Années			Quantités Tonnes			Valeurs Francs
1904	...	...	28,838	...	...	2,746,245
1905	...	...	29,680	...	...	3,163,379
1906	...	...	47,029	...	...	5,232,033
1907	...	...	83,184	...	...	7,686,158
1908	...	...	85,275	...	...	7,084,348
1909	...	...	58,347	...	...	3,702,379
1910	...	...	45,041	...	...	4,563,707
1911	...	...	138,845	...	...	8,100,046
1912	...	...	131,082	...	...	9,297,658
1913	...	...	124,968	...	...	14,299,315

Les Colonies productrices, d'après les résultats de 1912, peuvent être classées comme suit :

Colonies				Quantités Tonnes		Valeurs Francs
Gabon...	...	...	...	95,747	...	5,538,027
Côte d'Ivoire...		...	...	30,490	...	2,896,529
Madagascar ...		...	...	2,930	...	425,663
Indochine	...	...	...	1,330	...	332,861

Il est à noter que la Guyane et la Nouvelle-Calédonie produisent des bois précieux, dont l'exportation est encore faible en quantité, mais relativement importante en valeurs.

L'exportation des bois qui était en 1904 de 28,838 tonnes d'une valeur de 2,746,245 francs, s'est élevée en 1912 (année moyenne) à 131,082 tonnes d'une valeur de 9,298,000 francs.

Le Caoutchouc.

L'exportation du caoutchouc de cueillette ou de plantation provenant des Colonies françaises pendant la période décennale 1904-1913 s'est élevée aux chiffres suivants :

Années			Quantités Tonnes			Valeurs Francs
1904	...	...	6,188	...	...	31,929,114
1905	...	...	6,654	...	...	37,516,093
1906	...	...	8,379	...	...	45,429,950
1907	...	...	6,771	...	...	41,803,464
1908	...	...	4,768	...	...	29,169,501
1909	...	...	6,817	...	...	46,709,298
1910	...	...	7,617	...	...	64,450,414
1911	...	...	6,392	...	...	50,426,280
1912	...	...	6,820	...	...	46,898,045
1913	...	...	4,681	...	...	31,241,289

D'après les résultats de 1911 (année moyenne) les colonies productrices peuvent être classées dans l'ordre suivant:

Colonies	Quantités Tonnes	Valeurs Francs
Guinée...	1,896	15,173,536
Moyen Congo	1,416	14,338,899
Côte d'Ivoire ...	1,203	9,887,945
Madagascar	801	4,566,305
Gabon...	281	1,826,507
Haut Sénégal-Niger ...	258	1,745,401
Indochine	246	1,112,129
Nouvelle Calédonie ...	11	101,400

L'exportation qui était en 1904 (année moyenne) de 6,188 tonnes d'une valeur de 32 millions de francs, s'est élevée en 1912 (année moyenne) à 6,800 tonnes d'une valeur de 47 millions de francs.

Le maximum de la période envisagée a été atteint en 1906 avec 8,400 tonnes d'une valeur de 45,000,000 francs et le minimum en 1908 avec 4,800 tonnes d'une valeur de 29 million francs.

Il est à remarquer que les chiffres de l'exportation représentent exactement ceux de la production, le caoutchouc n'étant pas directement employé ni travaillé industriellement dans nos colonies.

La plus grande partie de ces caoutchoucs sont des caoutchoucs de cueillette; cependant il existe en Indochine des plantations importantes s'élevant approximativement à 68,557 hectares, dont 12,901 plantes de 4,005,011 pieds d'*Hevea brasiliensis*.

Le Sucre.

L'exportation des sucres provenant des Colonies françaises s'est élevée pendant la dernière période décennale 1904-1913 aux chiffres suivants:

Années	Quantités Tonnes	Valeurs Francs
1904	101,166	24,241,996
1905	84,429	29,065,257
1906	121,357	26,675,573
1907	138,092	38,582.124
1908	128,298	32,875,370
1909	106,792	28,167,284
1910	120,404	42,025,047
1911	127,604	40,870,731
1912	107,922	45,144,395
1913	109,266	29,306,062

Les Colonies productrices, d'après les résultats de 1912 (bonne année), peuvent être classées dans l'ordre suivant :

Colonies	Quantités Tonnes	Valeurs Francs
Martinique	39,499 ...	19,345,707
Guadeloupe	39,210 ...	16,445,009
Réunion	26,678 ...	8,072,020
Indochine	1,652 ...	337,575
Mayotte (Madagascar) ...	875 ...	344,084

Les chiffres de l'exportation, qui avaient été en 1904 (année faible) de 101,166 tonnes d'une valeur de 24,242,000 francs, se sont élévés en 1912 (bonne année) à 107,922 tonnes d'une valeur de 45,144,000 francs.

Une quantité considérable de ce produit, quantité qu'il est difficile d'évaluer, est livrée à la consommation locale.

Le Riz.

L'exportation du riz provenant de la production des Colonies françaises pendant les dix dernières années s'est élevée aux chiffres suivants :

Années	Quantités Tonnes	Valeurs Francs
1904	977,150	109,555,081
1905	623,630	69,719,908
1906	764,341	86,206,834
1907	1,430,428	153,875,199
1908	1,238,823	139,248,053
1909	1,099,999	147,925,867
1910	1,277,918	168,884,789
1911	877,178	118,529,326
1912	824,620	114,675,654
1913	1,297,499	178,234,248

D'après les résultats de 1913, année bonne moyenne, les Colonies exportatrices peuvent être classées comme suit.

Colonies	Quantités Tonnes	Valeurs Francs
Indochine	1,286,804 ...	176,367,274
Madagascar	10,664 ...	1,859,102
Guinée	29 ...	7,556
Sénégal	1 ...	316

Les chiffres donnés ci-dessus ne s'appliquent bien entendu qu'aux quantités livrées à consommation extérieure, on pourrait presque dire à l'excédent de la production sur la consommation locale.

Il faut, en effet, avoir présent à l'esprit que le riz est la base de la nourriture de la majeure partie des sujets coloniaux français et même de la population indigène tout entière de l'Indochine, de Madagascar, de nos possessions de l'Inde, etc.

Il est difficile d'évaluer la production réelle du riz dans l'ensemble de nos possessions, on peut cependant donner pour l'Indochine les approximations suivantes:

Production du Riz en Indochine.

Cochinchine.—Superficie consacré à la riziculture: 1,500,000 hectares—soit 27 pour cent de la superficie totale. La production totale y est estimée à 2,429,000 tonnes (1910), dont 2,150,000 utiles (1,200,000 tonnes environ allant à l'exportation). Chiffre de la population: 3,032,596 (1911).

Tonkin.—Superficie consacrée au riz: 828,781 hectares. Production tôtale estimée à 1,873,045 tonnes (coefficient de consommation par tête et par jour estimé à ok.650; ce chiffre me paraît assez élevé). Chiffre de la population: 6,119,620.

Cambodge.—Superficie en riziculture estimée à 675,000 hectares, soit 4·5 pour cent de la superficie totale. Production estimée à 627,000 tonnes. Population: 1,684,252.

Annam et Laos.—Les statistiques font défaut. Les récoltes y sont souvent déficitaires à l'égard de la consommation indigène.

La production des trois principaux pays riziculteurs—Cochinchine, Tonkin, Cambodge—se totalise avec:

2,429,000
1,873,000
627,000
4,929,000 tonnes

soit 5 millions de tonnes.

En admettant comme coefficient de consommation moyenne par tête et par jour en Indochine le chiffre de ok.300 (qui est plutôt faible) j'estime la consommation annuelle totale pour les 16 millions et demi d'habitants à environ 2 millions de tonnes—auxquels il fait ajouter la consommation du paddy par les bestiaux et l'industrie (alcool, etc.) difficile à évaluer même approximativement.

Production du Riz à Madagascar.

Le riz constitue à Madagascar la plus importante des cultures indigènes; aussi trouve-t-on cette céréale sur tous les points de la Colonie du Sambirano au Lac Alaotra et de Diego-Suarez au plateau des Baras.

Il est cultivé d'une manière intensive en Imerina et au Betsileo. Le riz est, en effet, la base de l'alimentation de l'indigène et sa culture s'étend sur près de 400,000 hectares (exactement 396,130).

Au dire des indigènes, la moyenne de la production de certaines régions varie de 1,000 à 2,500 kilos de paddy à l'hectare, alors que la moyenne de certaines autres oscille entre 2,500 et 3,000 kilos.

Si nous nous reportons, en outre, à diverses expériences faites à Tananarive sur des terres saines labourées à la charrue, les rendements y accusent un maximum de 4,000 kilos.

Ces diverses bases permettent d'établir un chiffre moyen de rendement d'environ 2,000 kilos, qui correspond à une production générale de 800,000 tonnes pour la Colonie, sur lesquelles 10,664 ont été exportées en 1913 en augmentation de 3,243 tonnes sur l'année 1912.

Le Manioc.

L'exportation du Manioc provenant de la production des Colonies françaises était insignifiante il y a dix ans et n'a commencé à prendre un certain développement que pendant les cinq dernières années. La courbe ascendante de l'exportation de ce produit est remarquable.

Les chiffres sont les suivants:

Années	Quantités Tonnes	Valeurs Francs
1909	716	101,924
1910	4,860	757,728
1911	13,914	1,707,116
1912	23,493	3,178,685
1913	23,913	3,184,248

Madagascar occupe incontestablement le premier rang dans le classement des Colonies productrices, d'après les résultats de 1913.

Colonies	Quantités Tonnes	Valeurs Francs
Madagascar	21,670 ...	2,938 630
Indochine	2,243 ...	245,579
Réunion	329 ...	61,910

Ces constatations sont d'autant plus intéressantes qu'elles s'appliquent à un produit dont le mouvement d'exportation s'est tout récemment affirmé.

Le Manioc est la base de l'alimentation des indigènes de certaines de nos colonies, notamment de nos colonies de l'Afrique Equatoriale; il entre également pour une part importante dans la consommation dans les possessions françaises d'Amérique et à Madagascar.

Le Café.

L'exportation du café provenant des cultures des Colonies françaises pendant la période décennale 1904-1913 s'est élevée aux chiffres suivants:

Années	Quantités Tonnes	Valeurs Francs
1904	1,147	2,313,929
1905	1,527	2,861,773
1906	1,400	2,924 047
1907	1.720	3,445.860
1908	1,670	3,340,581
1909	1.464	2,861,955
1910	1.808	3,869,337
1911	1,986	4,442.713
1912	2,146	3,950 960
1913	1,835	4,609,336

D'après les résultats de 1910 (année moyenne) les colonies productrices se classent dans l'ordre suivant:

Colonies	Quantités Kilos	Valeurs Francs
Guadeloupe	955,383 ...	2,486,123
Nouvelle Calédonie	518,927 ...	850,235
Réunion	117 179 ...	216,608
Madagascar	116,321 ...	182,912
Martinique	13 699 ...	29,196
Indochine	2,770 ...	5,540

Le maximum de l'exportation a été atteint en 1912 avec 2,146 tonnes d'une valeur de 3,951,000 francs et le minimum en 1904 avec 1,147 tonnes d'une valeur de 2,313,900 francs.

Le Cacao.

La production du cacao dans les Colonies françaises pendant la période décennale 1904-1913 s'est élevée aux chiffres suivants:

Années	Quantit Tonnes	Valeurs Francs
1904	1,080	1,638,522
1905	1,166	1,592,958
1906	1,366	2 026,262
1907	1,415	3,569,981
1908	1,421	3,123,297
1909	1,371	2,183,623
1910	1,525	2,557,659
1911	2,065	3,444,970
1912	1,601	2,552,241
1913	1,717	2,988,791

Les principales colonies productrices d'après les résultats de l'année 1912 (année moyenne) se classent de la manière suivante:

Colonies	Quantités Tonnes	Valeurs Francs
Guadeloupe	918	1,399,856
Martinique	501	879,130
Gabon	73	81,000
Madagascar et Dépendances	25	49,581
Côte d'Ivoire	20	41,908

La consommation locale du cacao étant de très faible importance, le chiffre des exportations peut être considéré comme s'approchant beaucoup des résultats de la production.

Les chiffres de 1904 étaient de 1,080 tonnes d'une valeur de 1,639,000 francs; ils se sont élevés en 1912 (année moyenne) à 1,600 tonnes d'une valeur de 2,552,000 francs.

La culture et la production du cacao sont en réel progrès dans les Colonies françaises.

Le Thé.

L'exportation par mer du thé provenant de la production des Colonies françaises s'est élevée pendant la dernière période décennale 1903-1912 aux chiffres suivants:

Années		Quantités Kilos		Valeurs Francs
1903	... ...	167,965	... ...	386,436
1904	... ...	331,788	... ...	837,193
1905	... ...	225,647	... ...	568,762
1906	... ...	367,962	... ...	927,612
1907	... ...	385,027	... ...	930,095
1908	... ...	313,827	... ...	768,935
1909	... ...	326,650	... ...	572,595
1910	... ...	537,958	... ...	947,463
1911	... ...	559,433	... ...	979,210
1912	... ...	435,718	... ...	762,556

L'Indochine est seule à retenir comme pays producteur et exportateur de thé; les autres colonies n'en produisent que de faibles quantités livrées à la consommation locale.

Il est très difficile de déterminer le chiffre de la production de l'Indochine où les différentes sortes de thé sont l'objet d'une importante consommation, dans toutes les classes de la population.

Il est difficile également de tenir compte des quantités exportées par les frontières de terre.

La Vanille.

Le tableau ci-dessous donne en quantités et en valeurs les chiffres de l'exportation de la vanille dans les Colonies françaises pendant la période décennale 1904-1913.

Années		Quantités Kilos		Valeurs Francs
1904	... ...	277,141	.. ...	3,235.691
1905	... ...	325,755	... ...	3.982,946
1906	... ...	371,545	... ...	3,947,728
1907	... ...	233,051	... ...	4,945,947
1908	... ...	346,448	... ...	3,583,478
1909	... ...	404,684	... ...	5,249,722
1910	... ...	423,294	... ...	5,700,592
1911	... ...	475,090	... ...	7,919,073
1912	... ...	415,629	... ...	10.227,635
1913	... ...	234,933	... ...	7,153,598

Les résultats de 1912 permettent de classer les colonies productrices dans l'ordre suivant, en quantités et en valeurs.

Colonies	Quantités Kilos		Valeurs Francs
Madagascar et Dépendances	206,502	...	7,496,907
Et. de l'Océanie	137,118	...	685,723
Réunion	52,165	...	1,606.432
Guadeloupe	16,921	...	334,524
Martinique	2,011	...	58 425
Gabon	912	...	45,624

Du tableau ci-dessus il ressort que l'ensemble de la production qui était de 277,141 kilos d'une valeur de 3,236,000 francs en 1904 s'est élevé à 415,629 kilos d'une valeur de 10,228,000 francs en 1912 (année moyenne) et 235,000 kilos d'une valeur de 7,154,000 francs en 1913 (mauvaise année).

Il y a lieu de considérer que les chiffres de l'exportation ci-dessus donnés correspondent à peu près exactment au chiffre de la production, la consommation locale étant très faible.

Les relevés connus de la production mondiale de la vanille permettent de constater que cette production s'est élevée à 600 tonnes en 1911; la production des Colonies françaises a été à cette époque de 475 tonnes qui représentent environ les deux tiers de la production mondiale en quantité. La proportion est très différente en valeurs étant donnés les prix élevés des vanilles du Amérique Centrale et les bas prix de nos vanilles océaniennes.

Le Poivre.

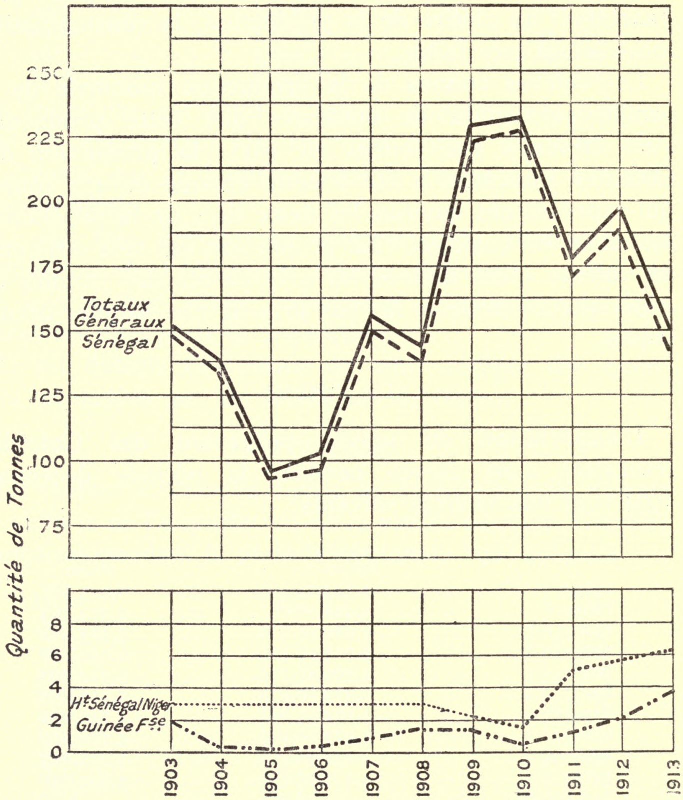
L'exportation du poivre provenant des Colonies françaises s'est élevée pendant la période décennale 1904-1913 aux chiffres suivants:

Années	Quantités Tonnes	Valeurs Francs
1904	5,343	6,413,888
1905	4,428	5,313,563
1906	4,986	5,983,312
1907	5,025	6,030,788
1908	4,760	5,712,806
1909	6,373	5,736,850
1910	4,161	3,746,134
1911	4,217	3,796,274
1912	3,634	3,256,515
1913	4,437	3,993,731

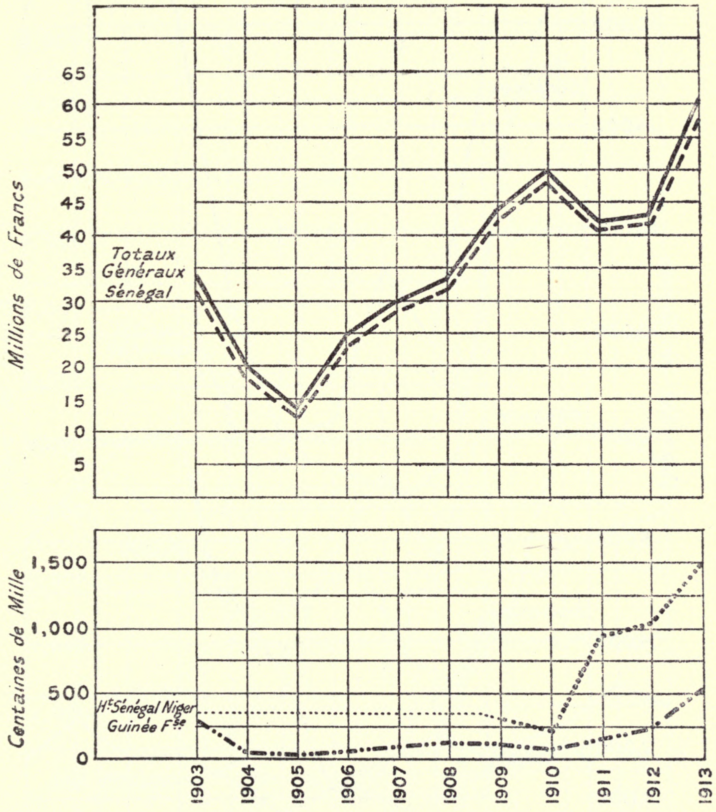
C'est l'Indochine qui occupe incontestablement le premier rang parmi les colonies productrices de cette denrée; on peut même dire qu'elle est la seule dont le chiffre d'exportation soit à retenir.

Le maximum de l'exportation a été atteint en 1909 avec 6,373 tonnes d'une valeur de 5,737,000 francs et le minimum en 1912 avec 3,634 tonnes d'une valeur de 3,257,000 francs.

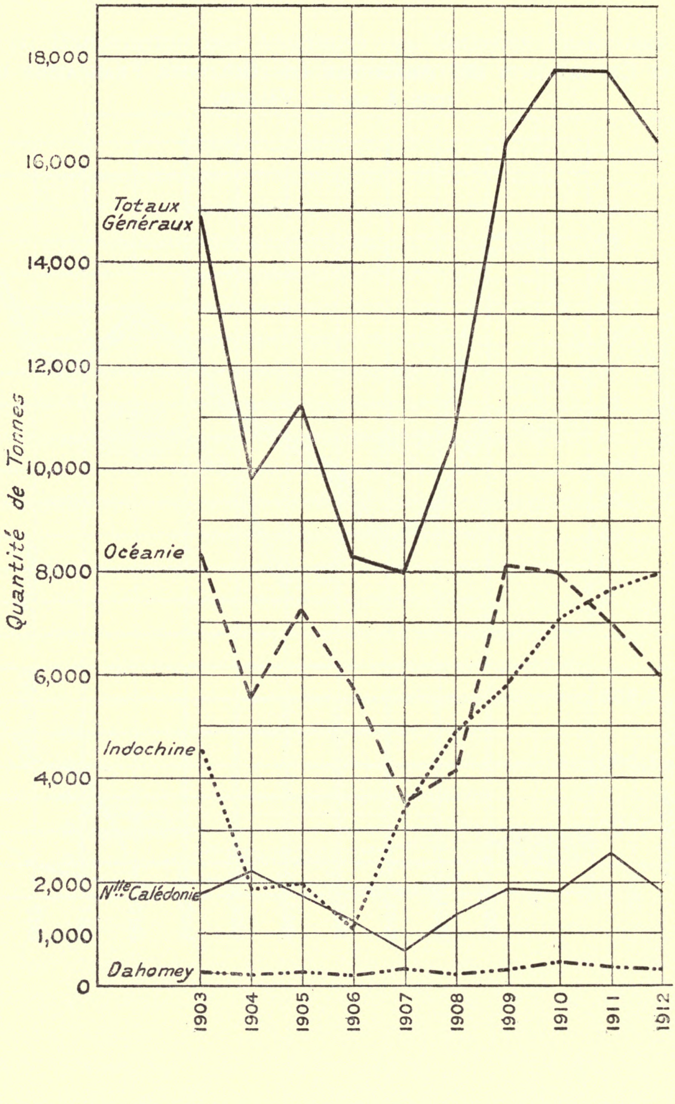
(1) Exportation des Arachides des Colonies Françaises de 1903 à 1913. Quantité.



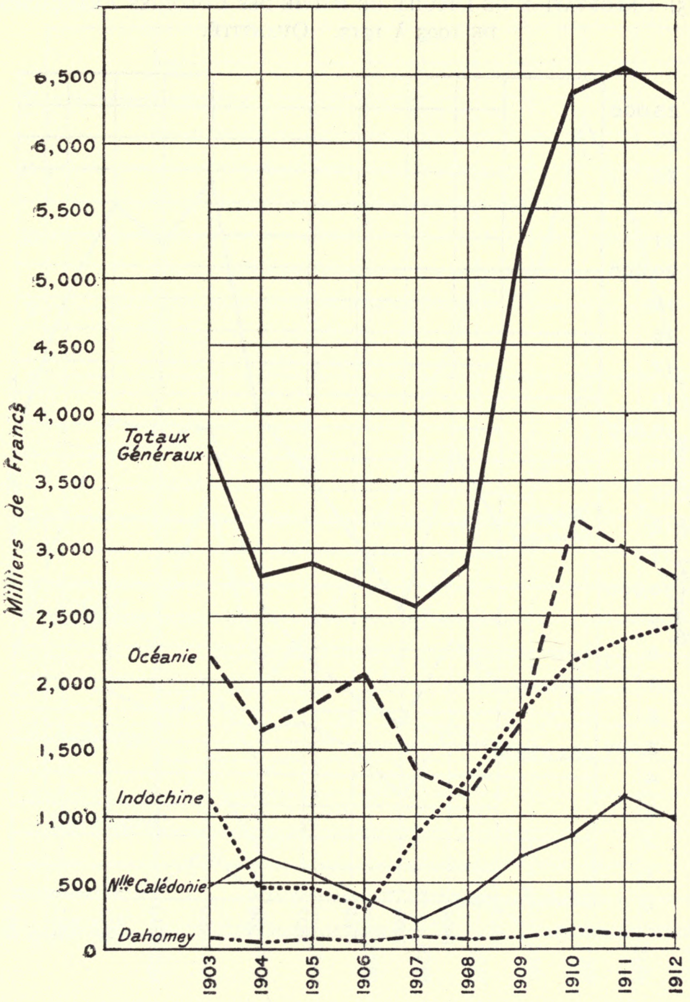
(2) EXPORTATION DES ARACHIDES DES COLONIES FRANÇAISES DE 1903 À 1913. VALEUR.



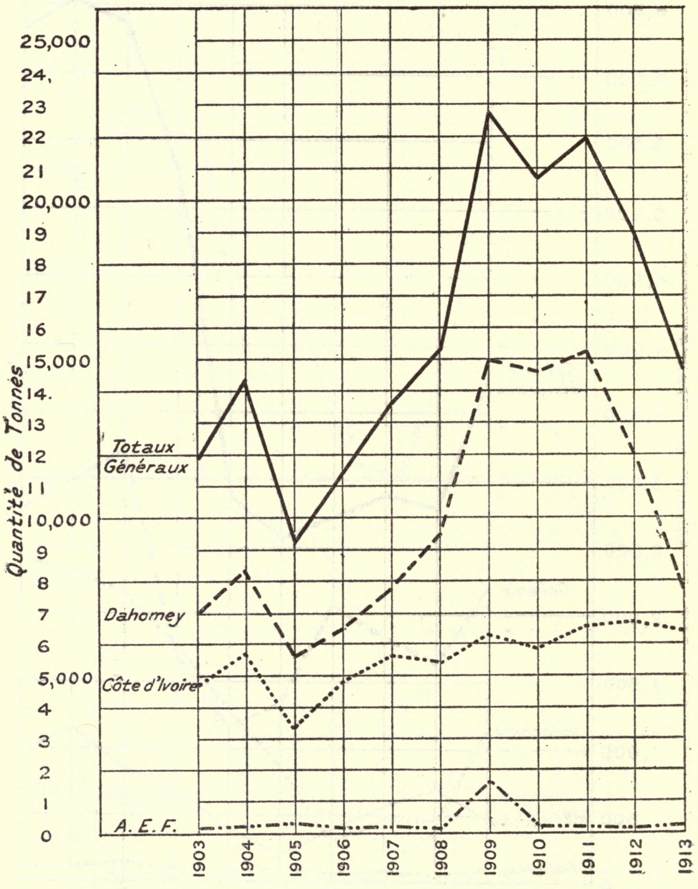
(3) Exportation du Coprah des Colonies Françaises de 1903 à 1912. Quantité.



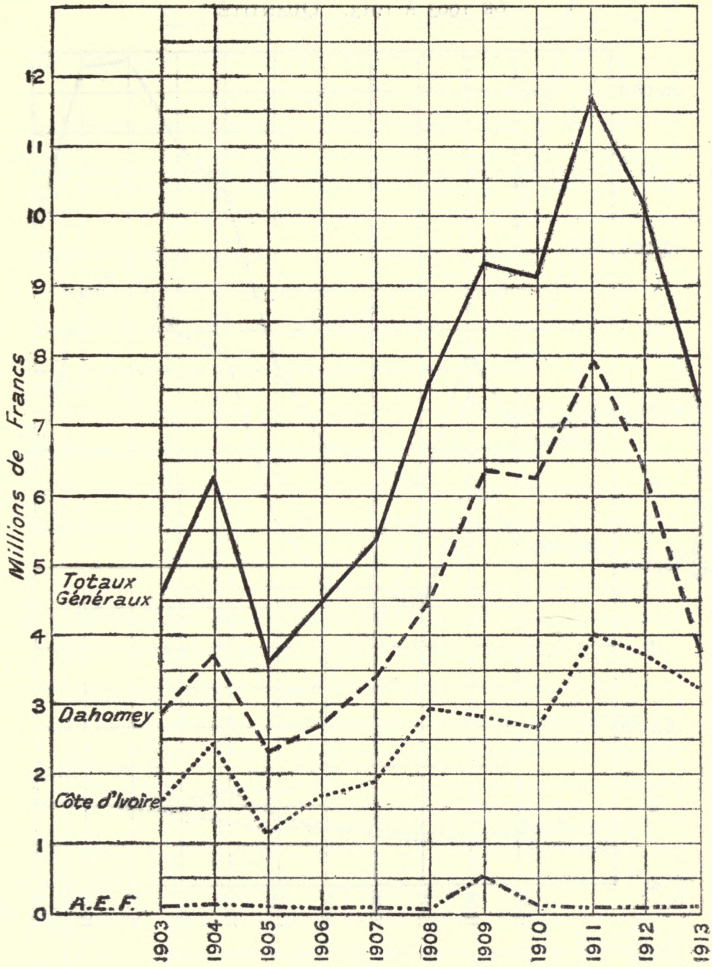
(4) EXPORTATION DU COPRAH DES COLONIES FRANÇAISES DE 1903 À 1912. VALEUR.



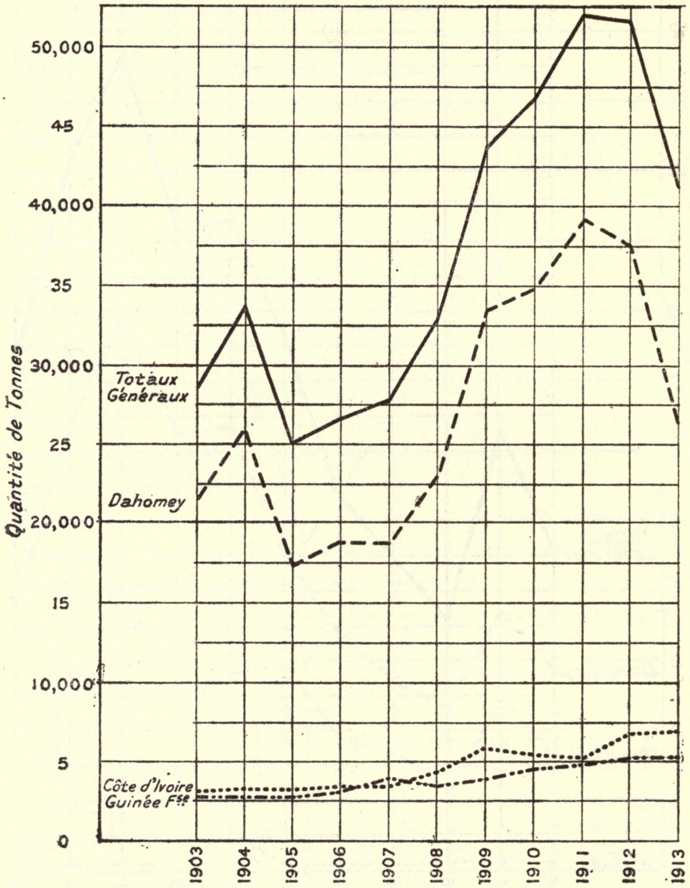
(5) Exportation de l'Huile de Palme des Colonies Françaises de 1903 à 1913. Quantité.



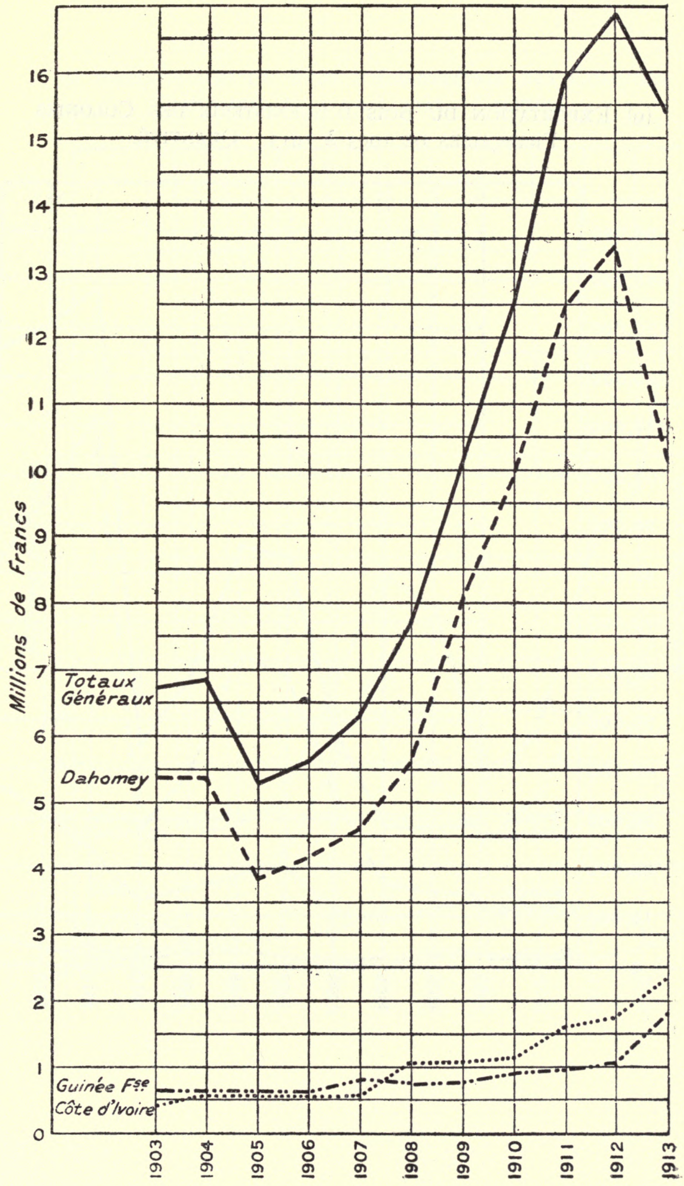
(6) EXPORTATION DE L'HUILE DE PALME DES COLONIES FRANÇAISES DE 1903 À 1913. VALEUR.



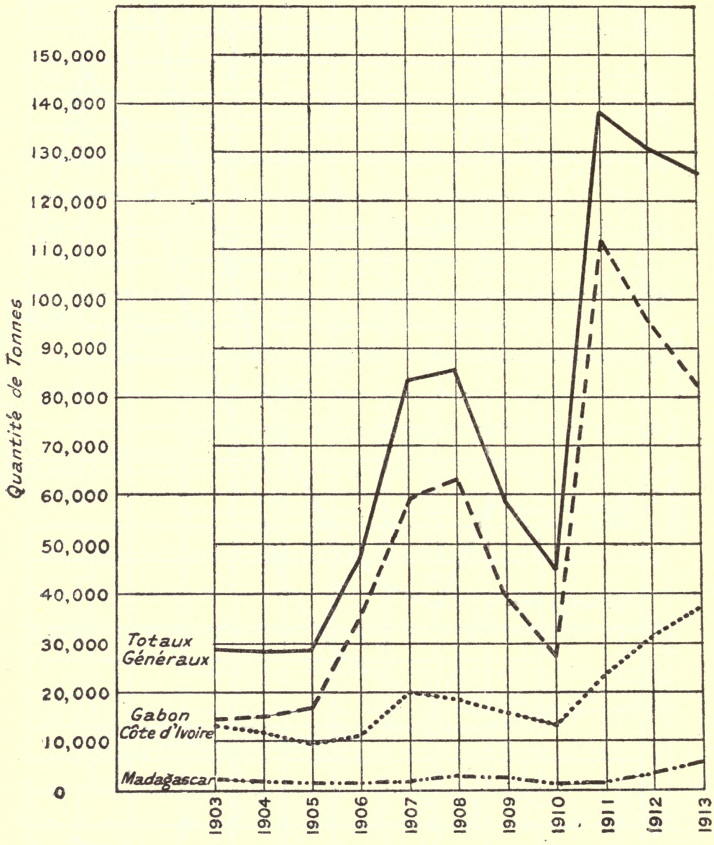
(7) Exportation des Amandes de Palme des Colonies Françaises de 1903 à 1913. Quantité.



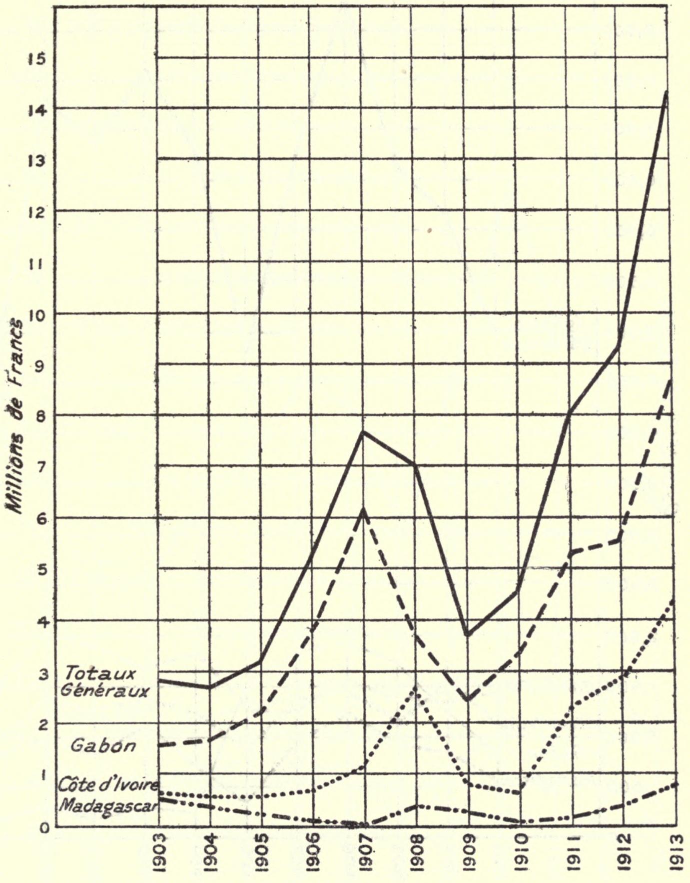
(8) Exportation des Amandes de Palme des Colonies Françaises de 1903 à 1913. Valeur.



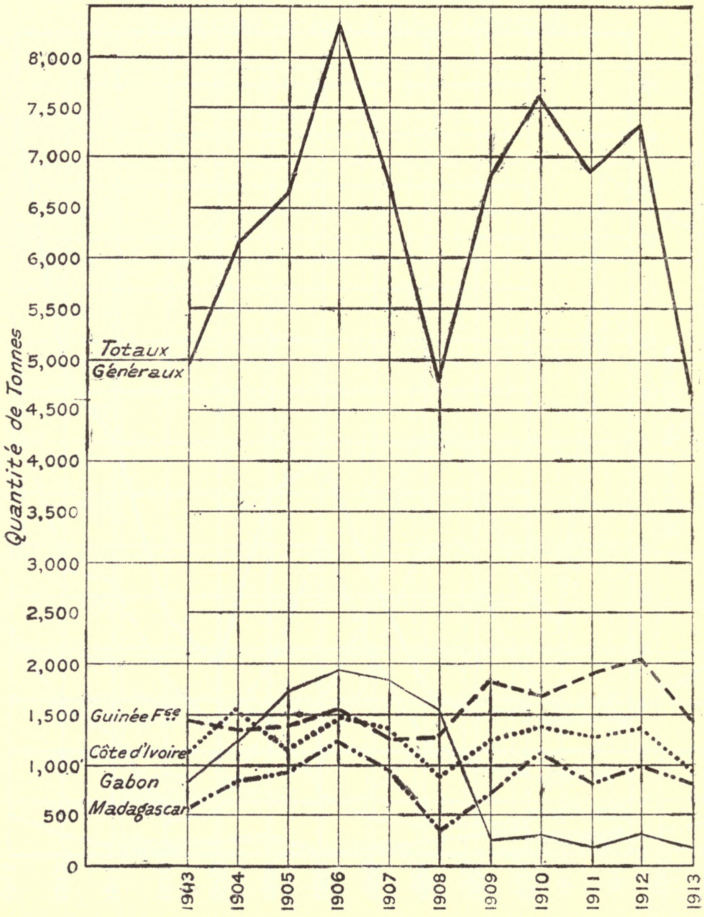
(9) Exportation du Bois d'Ebénisterie des Colonies Françaises de 1903 à 1913. Quantité.



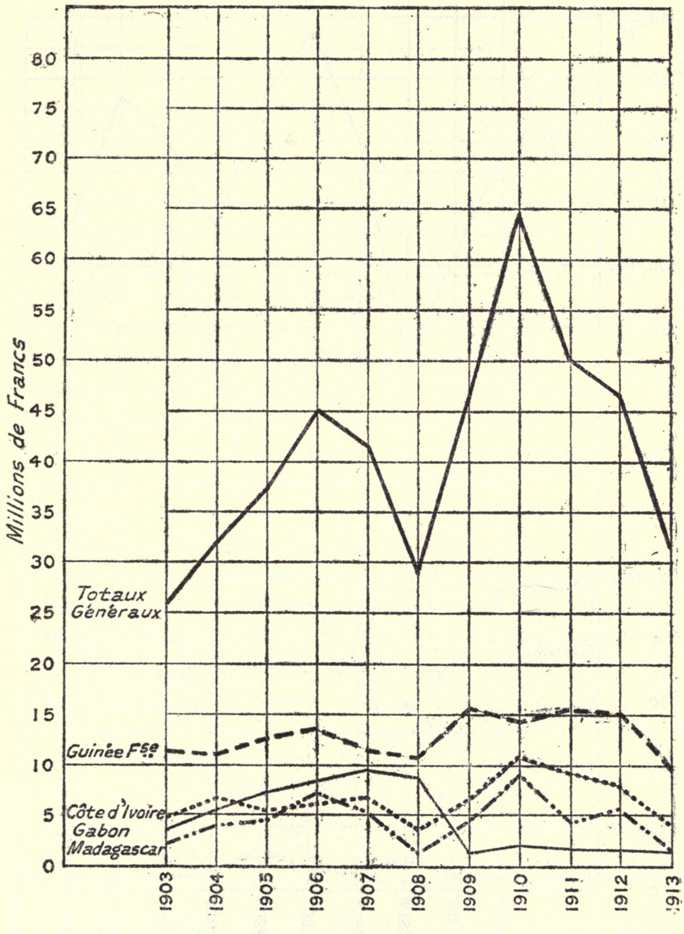
(10) EXPORTATION DU BOIS D'EBÉNISTERIE DES COLONIES FRANÇAISES DE 1903 À 1913. VALEUR.



(11) EXPORTATION DU CAOUTCHOUC DES COLONIES FRANÇAISES DE 1903 À 1913. QUANTITÉ.



(12) EXPORTATION DU CAOUTCHOUC DES COLONIES FRANÇAISES DE 1903 À 1913. VALEUR.



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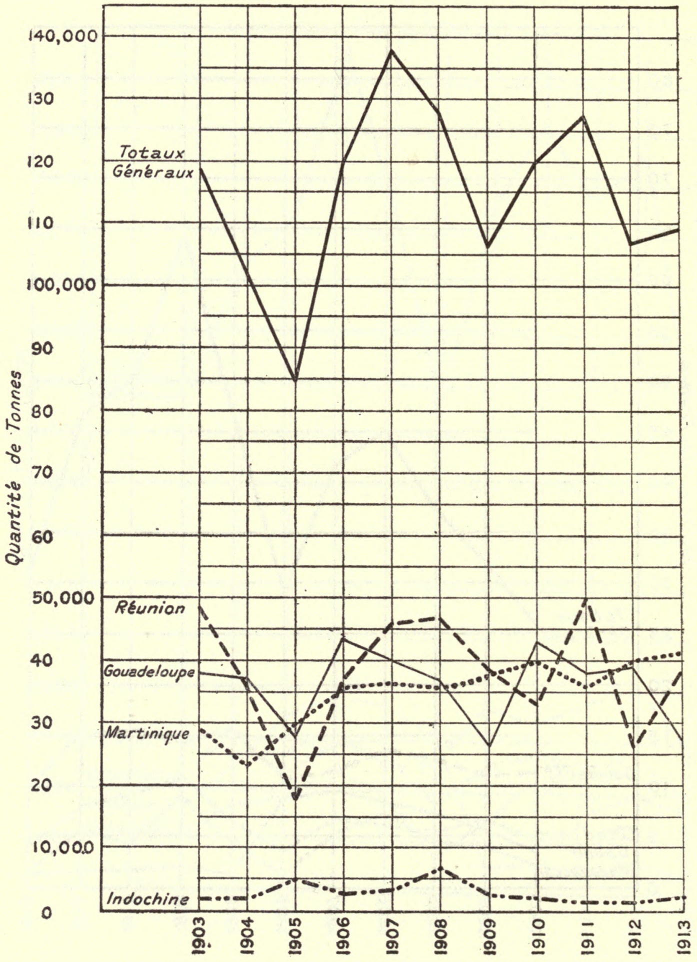
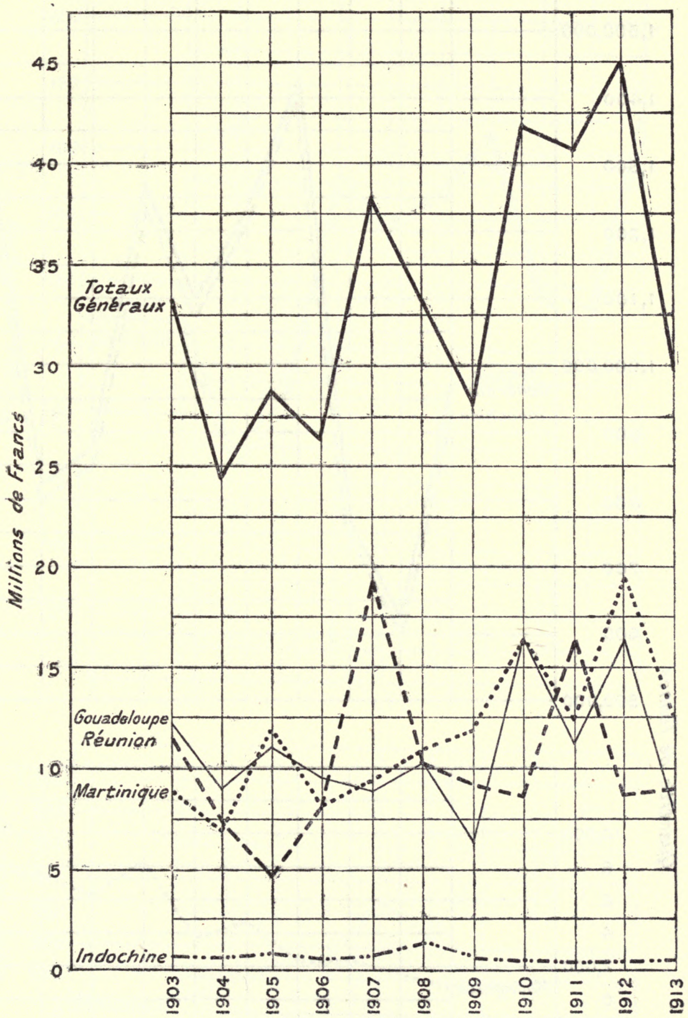


(14) Exportation du Sucre des Colonies Françaises de 1903 à 1913. Valeur.



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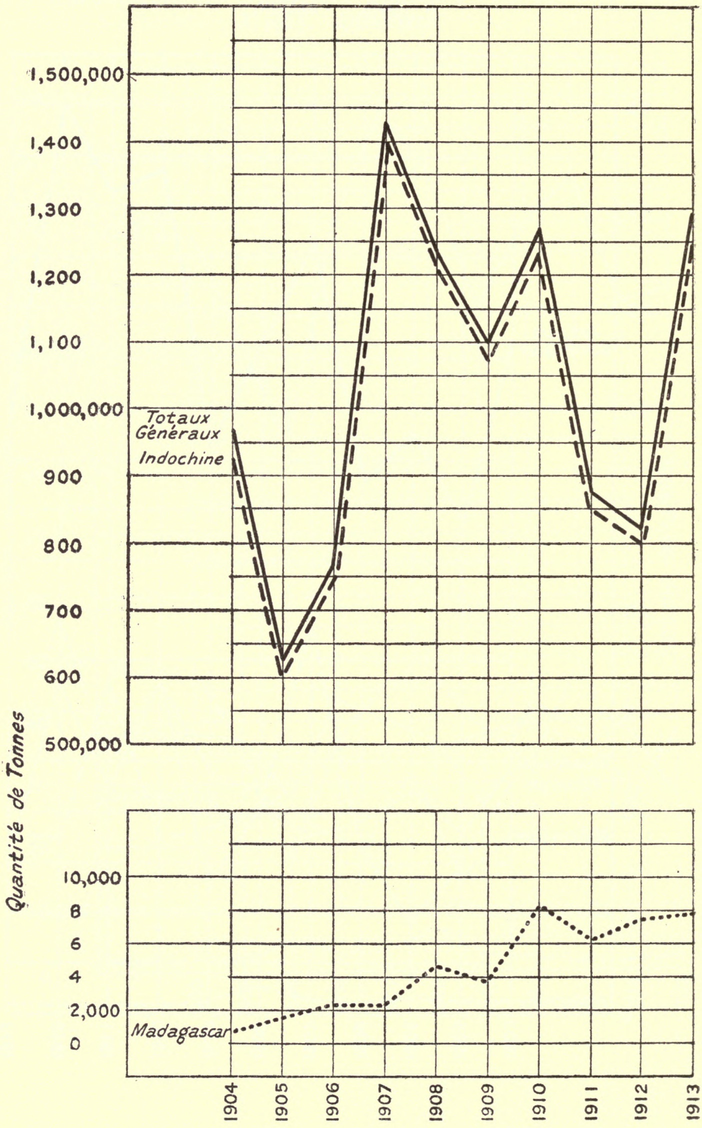

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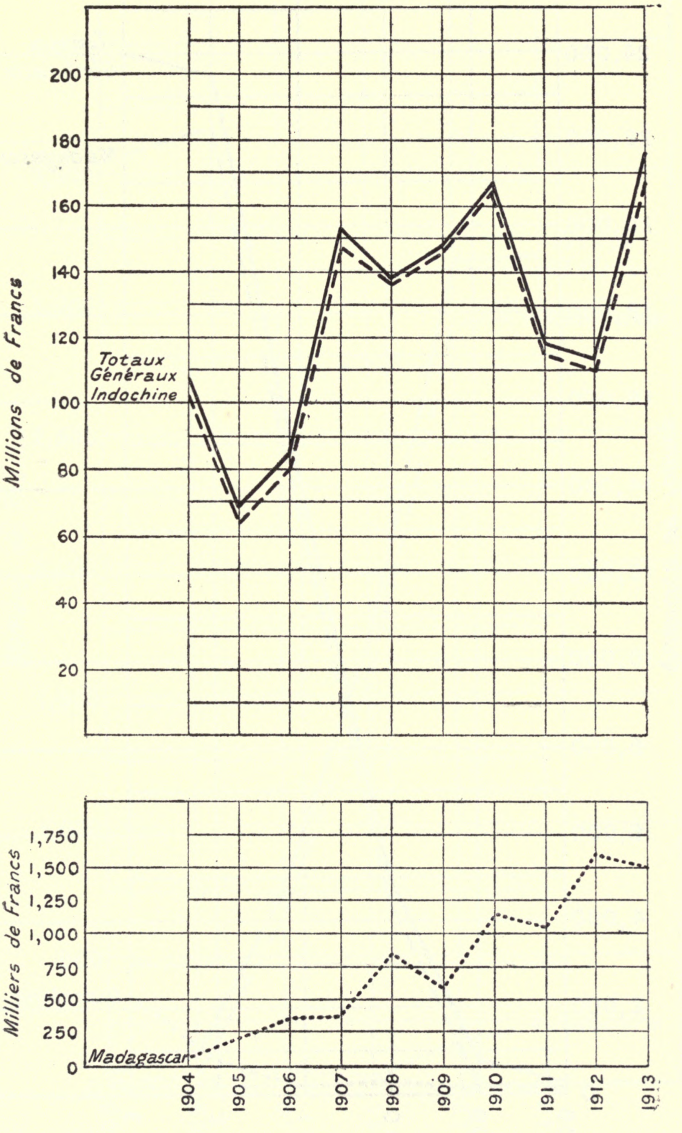

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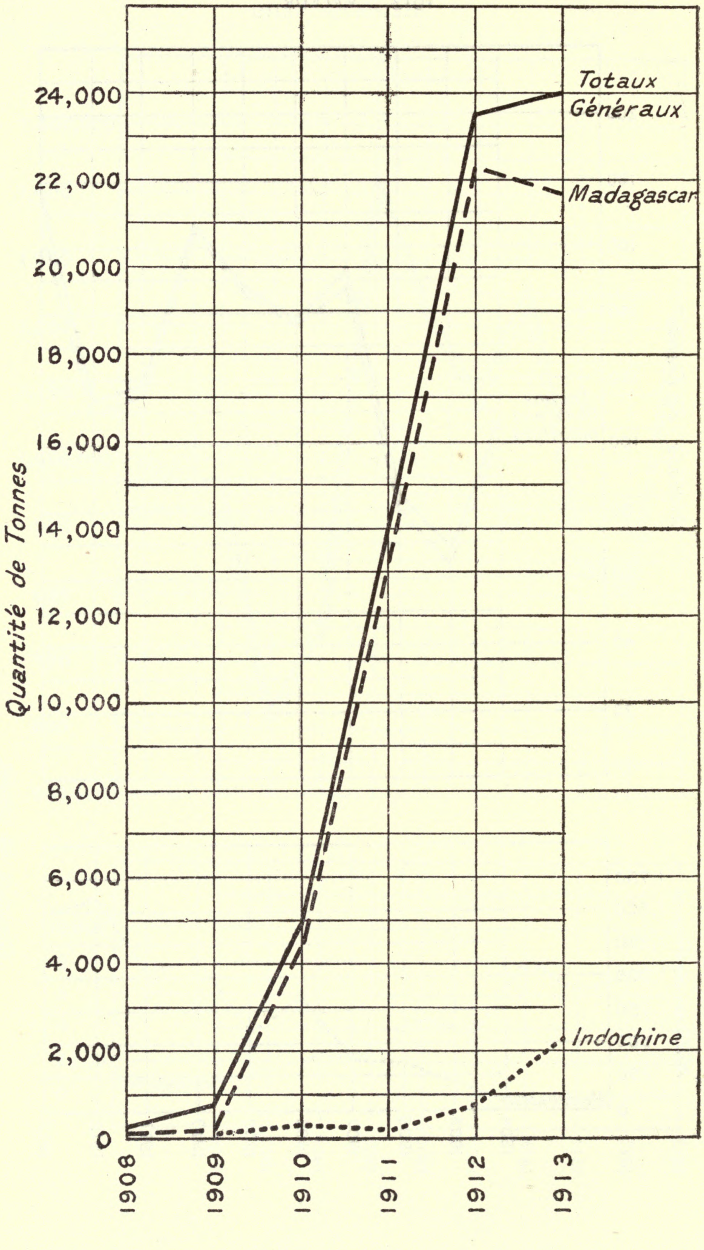

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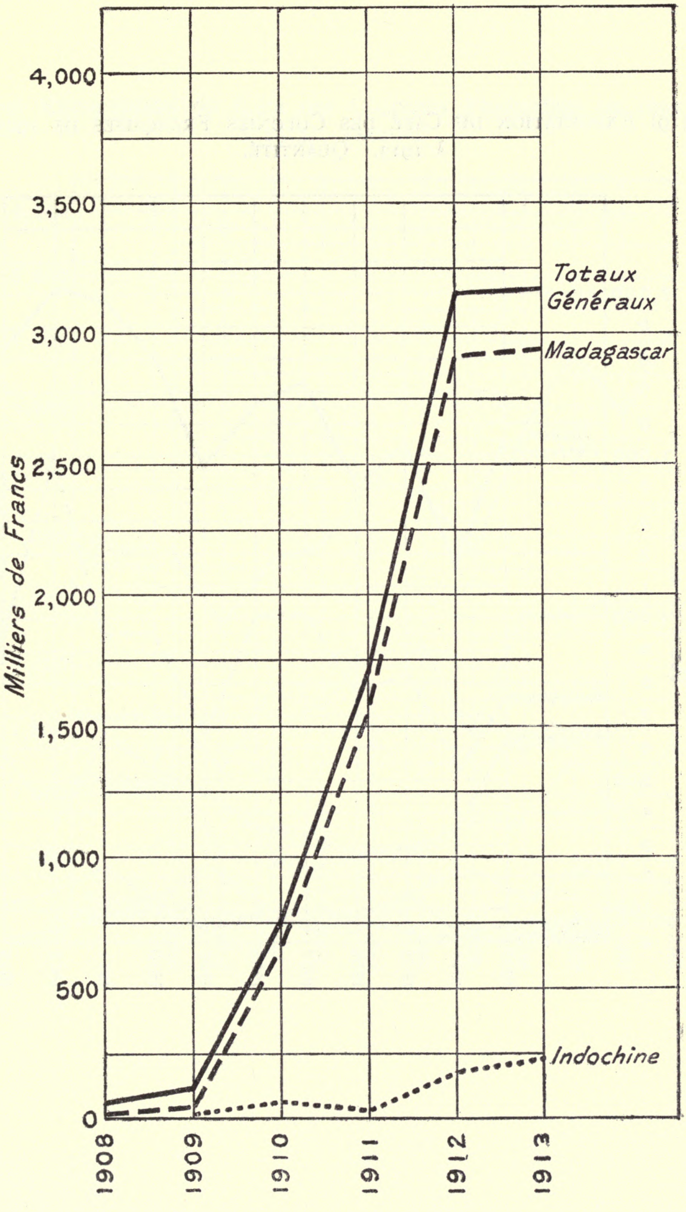

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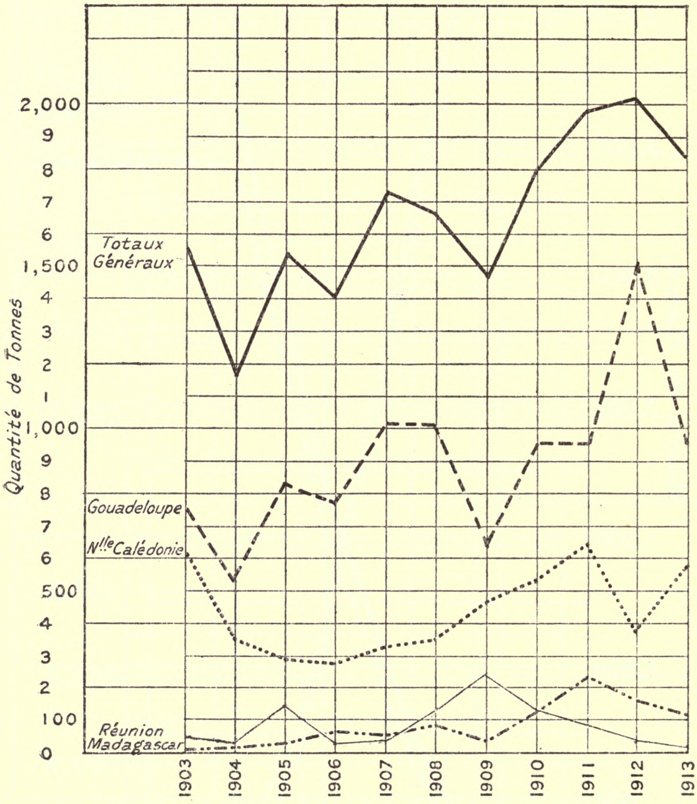

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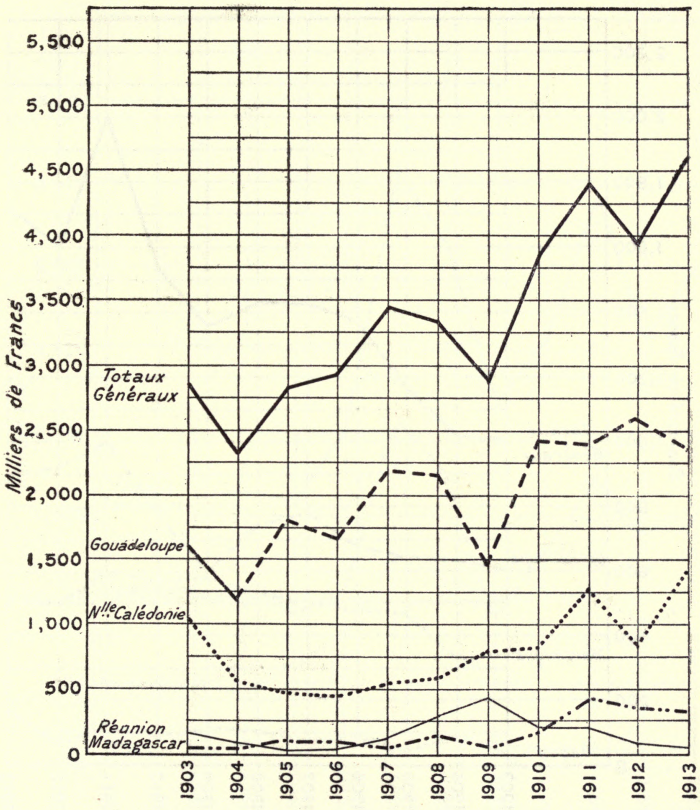

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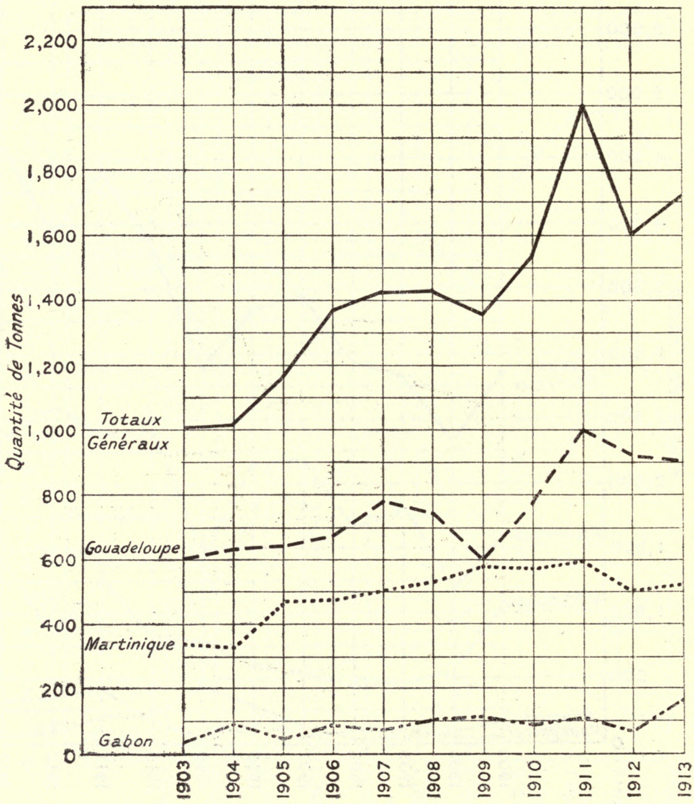

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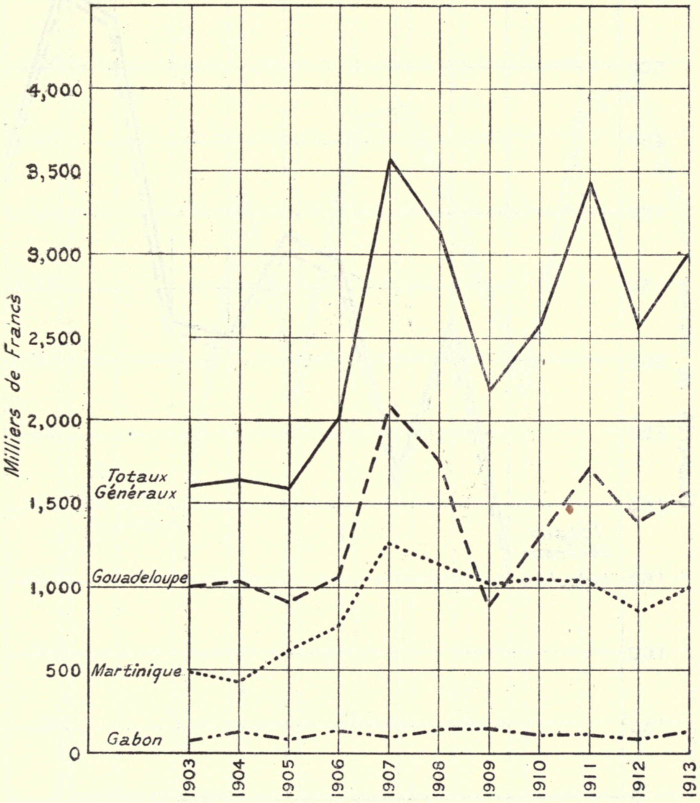

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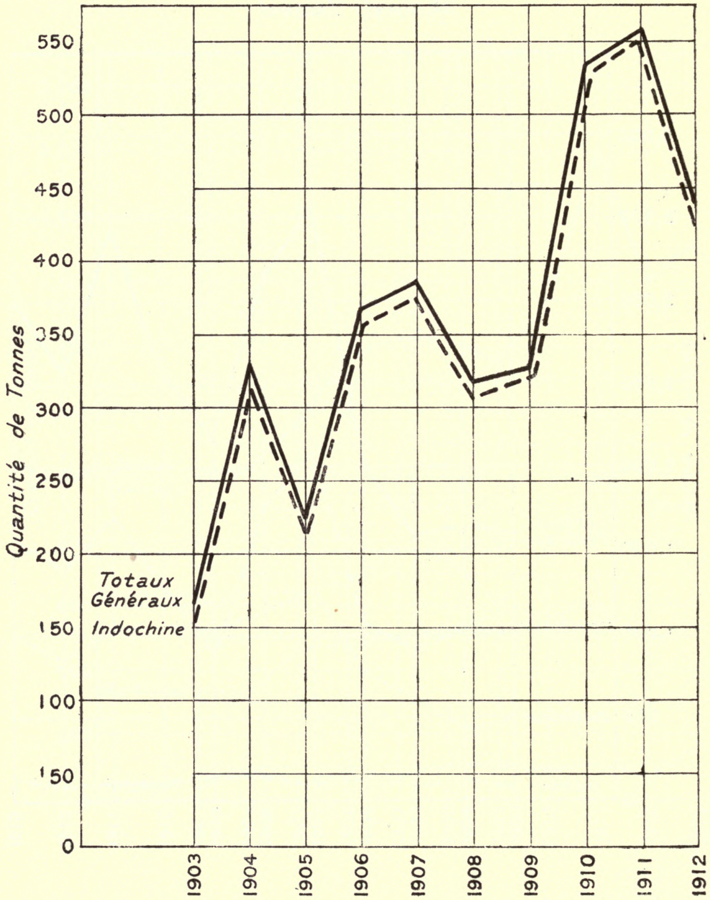

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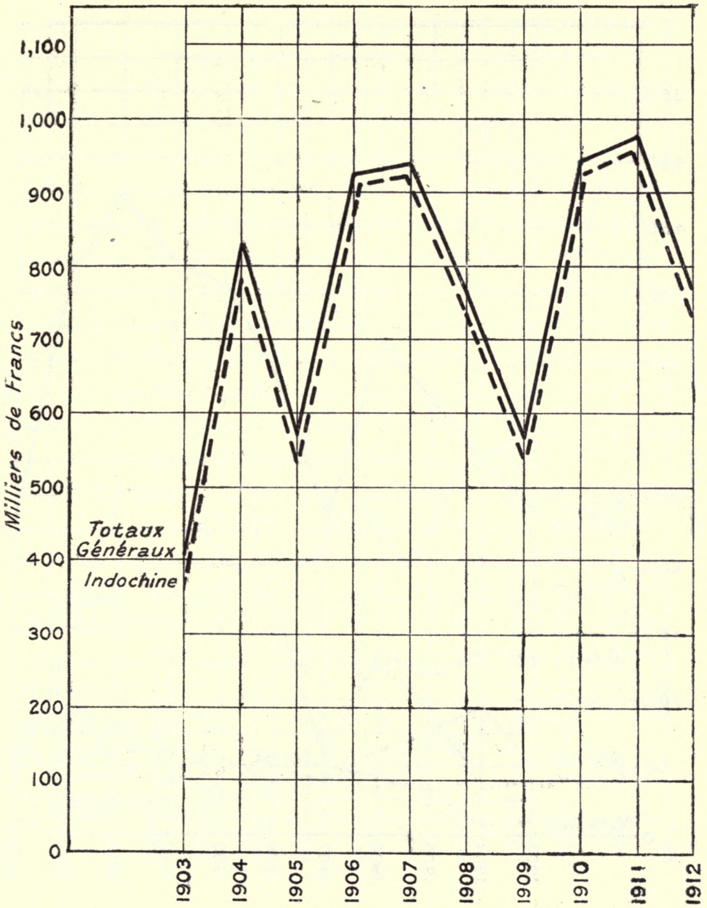

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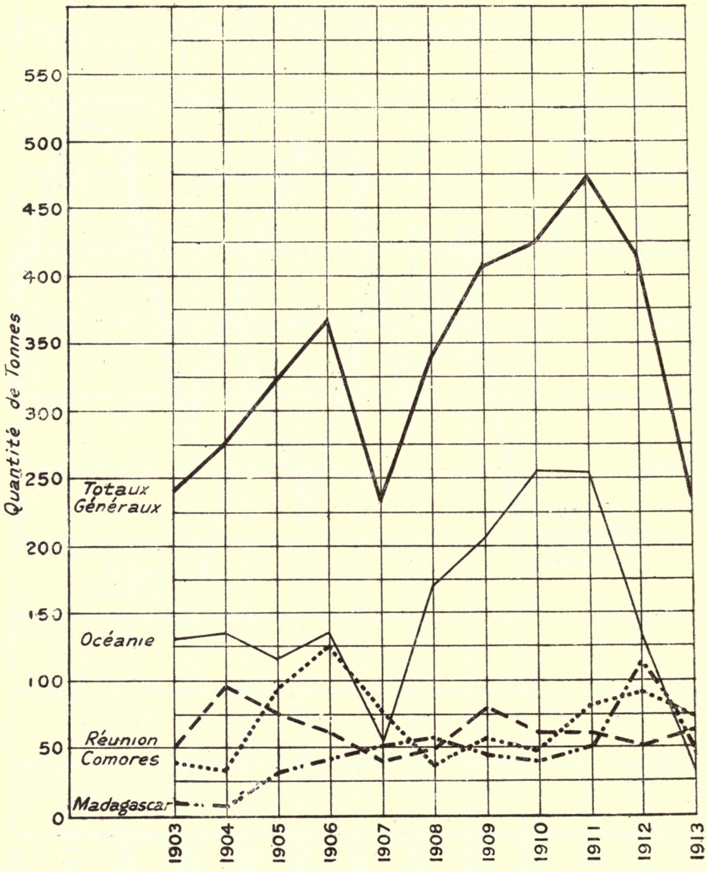

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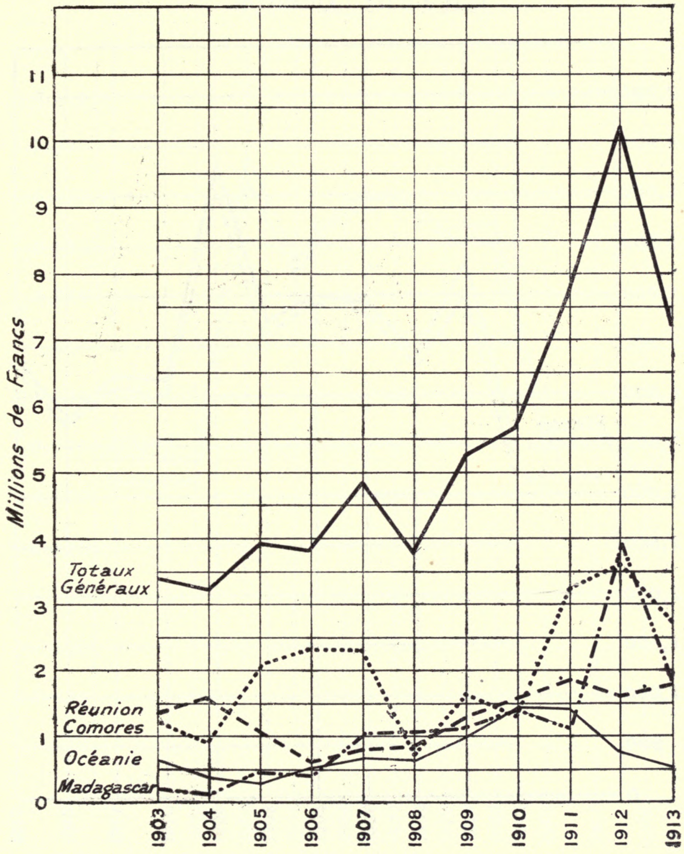

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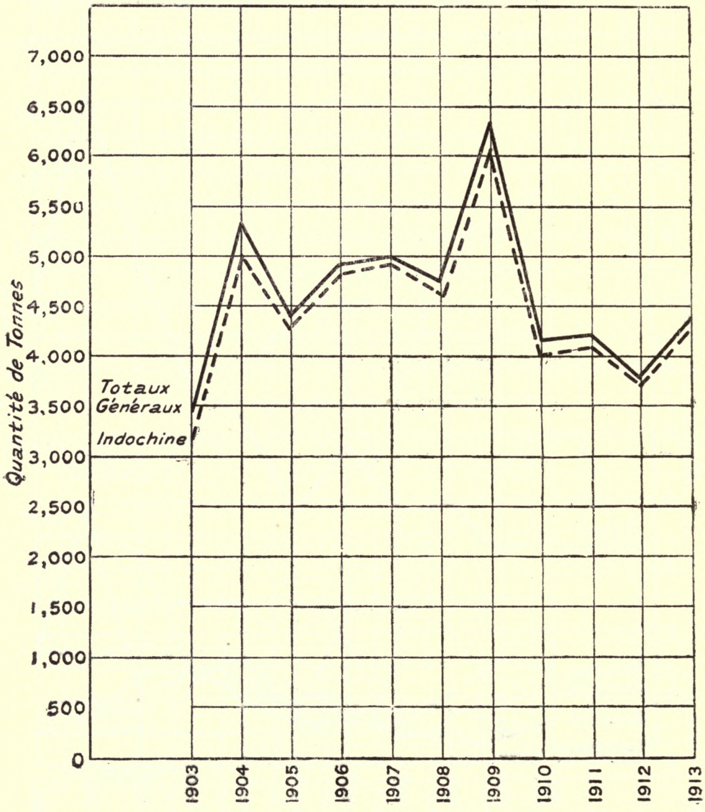

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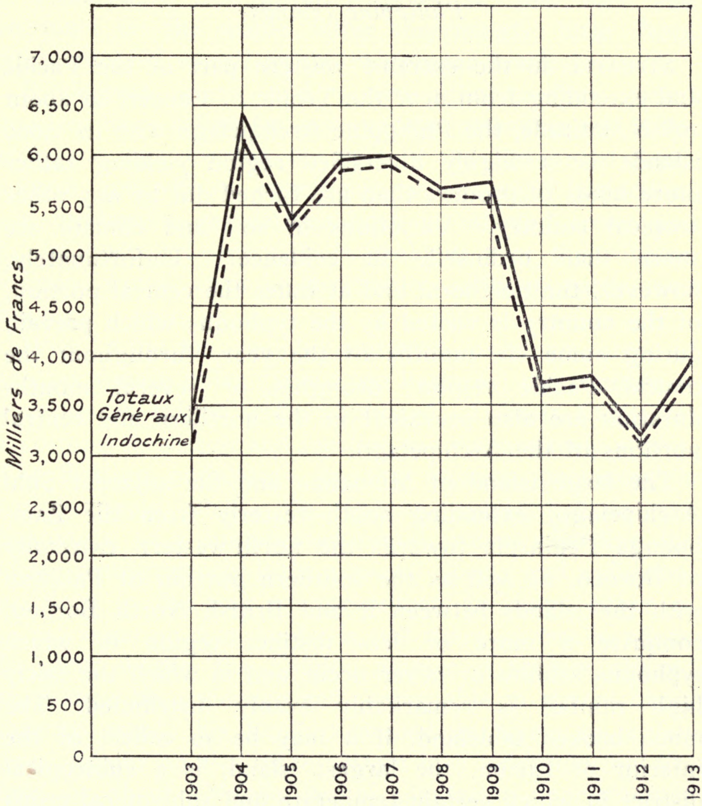

SOME NEW OR LITTLE KNOWN PHILIPPINE PRODUCTS.

By O. W. Barrett.

Chief, Division of Horticulture, Bureau of Agriculture, Philippine Islands.

Situated in the extreme western part of the Pacific and extending from near the Tropic of Cancer, to about 10° N. latitude, the Philippine Archipelago with its 1,000 islands is a highly diversified region yielding rather more kinds of product than are turned out by any other tropical country. Variations in soil and climate are more than ordinarily in evidence. Unfortunately, however, the northern, and at times the central portion, of the country is visited by the typhoons which prevail, during some six months of the year, throughout the central Pacific region; droughts of several months duration are also prevalent in the northern and central portions of the Archipelago.

The large island of Mindanao and the adjacent Sulu Archipelago, extending south-westerly from the Zamboanga Peninsula towards the north-western extremity of Borneo, as well as the southern portion of Palawan with the islands between it and British North Borneo, comprise a more or less distinct region in which typhoons seldom or never occur and in which the fairly high rainfall is remarkably evenly distributed. The much broken tableland, if it may be so called, of the interior of Luzon, the largest island, is a subtropical district in which certain temperate and subtropical crops can be handled with some success. Frost, of course, occurs in January, February and March, on the higher reaches of the mountains in Nueva Ecija, and the sub-provinces of Benguet, Lepanto, Bontoc, and Kalinga.

Hailstorms are practically unknown, though one striking case of this kind did occur in southern Luzon in April, 1914. In the rainy season lightning is sometimes destructive, but as compared with most temperate and some tropical countries it is a negligible feature. The rainfall for the lowlands of the northern (Luzon) and central (Visayas) parts may be put down at about 60 to 80 in. per annum; in the southern section it ranges from about 80 to 100 in.

Insect pests are, with the exception of migratory locusts, only ordinarily prevalent. Sugar-cane thus far is remarkably free from troubles of this sort and coconuts on the whole suffer surprisingly little from either the red weevil or the rhinoceros beetle.

Rinderpest, surra and a few other serious animal diseases have called for very careful attention and some stringent measures on the part of the Bureau of Agriculture, and without expert supervision, rigid inspection, and quarantine regulations both in infected zones and in the ports of entry, it is probable that the Filipino farmers would soon be practically without cattle and horses.

With 7,500,000 people scattered over an area of 119,542 square miles (31,000,000 hectares) the country as a whole is rather under-populated. Labour therefore, according to season and locality, is comparatively scarce. The floating population in the interior provinces is comparatively small; the custom, established by the Spaniards, of a complicated rental system affording the lessee comparatively little personal liberty and individual privilege in the way of agricultural holdings either of forest areas or crop lands, is still more or less in effect. In other words, the Filipino planter is seldom obliged to change his residence and, being able in almost every case to satisfy his family's immediate wants by a few days' labour on the share system in a neighbouring rice field or abacá (Manila hemp) plantation supplemented by a small patch of sweet potatoes, maize, and bananas, he is naturally loath to travel even into the next town to seek employment even at a comparatively high wage rate.

Looking at the matter in perspective, therefore, we see a highly diversified country, inhabited by some thirty more or less distinct branches of the Malay race. The agricultural operations, broadly considered to include everything from gathering gutta-percha to poultry raising, are managed in a haphazard, rule-of-thumb sort of way. In almost every case outside of the larger crops such as sugar, coconuts, abacá and tobacco, small unit farms, clearings and cultivated fields are the rule. Through the several tribes' lack of trust in each other and petty mutual jealousy there has been comparatively little exchange of either methods or materials, which predicates a highly localized, not to say specialized, agriculture. Obviously then one should expect a wide range of Philippine products and a large list of economic materials seldom or never found outside certain restricted localities in this country.

The following notes are based partly on the writer's personal observation and, especially as to statistics, on the Annual Report of the Insular Collector of Customs for the fiscal year ended June 30, 1913.

Vegetable Products.

Timber.—After a number of years' earnest effort on the part of the Bureau of Forestry to interest other countries in the excellent woods of the Philippines, figures are beginning to indicate that there is a rapidly growing appreciation of at least a dozen or more of the better sorts of our timber. The total export value of timber, including logs in the rough, for the fiscal year 1913, however, was only about £19,000; this figure could easily be quadrupled without drawing heavily upon the 40,000 square miles of forest. There are over 500 species of woody plants now known in the Philippine Islands and new species are continually being described by the Botanist of the Bureau of Science. Some 200 of these are of commercial importance. A rather large number are peculiar to the Archipelago.

Palm Sugar and Alcohol.—Passing over the well-known abacá or Manila hemp, sugar-cane, tobacco and cereals, one of the most interesting vegetable products of the Philippines is palm alcohol. Although certain local restrictions in the way of internal revenue, transportation, etc., inhibit this industry, the provinces of Cagayan, Pangasinan, Pampanga, Bulacan, and Capiz may be expected gradually to increase their output.

With the new Hines process of making high-grade sugar from the various palm saps, there is a splendid field for the manufacture of at least several thousand tons per annum of nipa palm sugar here. Vast swamps, covering hundreds of square miles, exist in the above-mentioned provinces and with the exceedingly cheap water transportation of the tuba or sap, from the tide marshes to the distilleries, there should be a splendid profit in this self-maintaining crop. Although this palm is strictly a salt-water species, it is stated on good authority that the drought of 1912-13 did actually affect the tuba yield of the nipa swamps, the explanation being that although the roots were, of course, unaffected the leaves normally require a certain amount of rain for their best activity.

Coconut tuba to the amount of over 42,000,00 litres (about 8,500,000 gallons) is produced here annually. Most of this is fermented and distilled into a low-grade alcohol. With the newly discovered (Hines) process, however, it will be possible to turn a portion or all of this tuba into a high-grade sugar. The sucrose content is about 15 per cent. of the fresh juice; in other words, about 3½ quarts of juice will produce 1 lb. of sugar. The burí (*Corypha elata*) abounds in Mindoro, Pangasinan, Batangas, Cebu, and the island of Mindanao; this palm also is tappable to a larger extent than is usually realized. The crude methods of manufacture in use by the local inhabitants, however, turn out only a dark-coloured, syrupy sugar, which is not at all suitable for export. When it is considered that a mature tree will yield 20 to 30 quarts of sap containing over 15 per cent. of sucrose per day over a period of two to three months, some idea of the tremendous profit obtainable from an acre of these wild palms may be realized.

A simple process has been devised recently by which it is possible to produce more than twice as much sugar per acre from the Kaong, or sugar palm (*Arenga saccharifera*), as from sugar-cane. Details of the method are published by the Bureau of Agriculture in the *Philippine Agricultural Review* for May, 1914. Although this palm is one of the oldest agricultural crops known, being mentioned in Sanskrit writings some 4,000 years ago, it has only just recently become of any real importance. The sugar obtainable in East Indian and Malayan markets, while of good flavour, is filled with impurities and has, of course, a bad colour. The chemical composition of the sugar is identical with that of the sugar-cane and while the protein content is slightly higher than that of either the sugar beet or sugar-cane, the content of sucrose, ranging to over 16 per cent., more than offsets this disadvantage. Trouble with the precipitation of the albuminoid substances, gums, pectins, etc., has been the principal reason hitherto for the failure to produce a fine white sugar from this palm. Mr. C. W. Hines, Sugar Expert of the Bureau of Agriculture, has devised a very cheap method for precipitating these substances. Briefly, it is as follows: the juice is heated nearly but not quite to the boiling point and then allowed to cool. The albuminoid substances, coagulated by the heat, fall within a few minutes as a whitish layer at the bottom of the receptacle; the clear sap is decanted off and the residue treated in a similar manner to sugar-cane precipitates. A small amount of milk of lime is then stirred into the still warm sap, and this is carbonated by blowing into it a current of gas (filtered to remove soot, etc.) from the chimney, or, if limestone is at hand, a very small furnace would furnish a flow of high-grade gas. The second precipitate, consisting largely of the pectins, gums, etc. (which, if boiled with the sucrose cause discoloration of the finished product) are either allowed to settle or are strained out. Boiling then proceeds in the regular manner and a fine-flavoured product, fully as white as that obtainable in the ordinary cane-sugar factory, is produced.

Considering the fact that for a period of 15 to 25 years the sugar palm requires practically no attention from the planter, coupled with the fact that old palms may be utilized for starch—each trunk giving from one to three bushels of a fine white article—we are obliged to admit that the tropics now have another first-class crop plant. In passing it may be mentioned that the sugar palm seems to be more at home in the Philippines than elsewhere; it begins flowering at 4 to 6 years of age, and continues to produce from one to four tappable (male) flower racemes each year for at least 15, and probably in well-cared-for plantations, more than 25 years.

Sago.—Sago is produced locally in the Agusan Valley of northern Mindanao to a limited extent. The vast swampy forests of this palm, of which there seem to be two varieties, could and should yield thousands of tons annually. This palm fortunately sprouts from the stump, a stand therefore merely requiring to be thinned out from time to time.

Almáciga.—This resin, which belongs to the kauri class, is the product of a coniferous tree (*Agathis alba*, (Lam.) Foxworthy), found throughout southern Mindanao, the islands of Negros, Mindoro, and in the higher districts of Luzon. The tree, known locally as Adlangao, Sateng, Baltik, etc., attains a large size and prefers mountain slopes. It is most abundant at between 400 and 1,000 metres elevation. The yellowish or brownish amber-like semi-transparent resin "accumulates as a hardened produce on the trunk after incisions are made in the bark, or at the base of the trunk, where it is deposited in the ground through ruptures made usually near the junction of the roots and the trunk. The latter deposits remain in the ground after the tree dies and decays and are discovered by collectors, who thrust a sharp pointed stick in the ground to determine their location."[1]

The collecting is usually done by the hill people, or "non-Christian tribes," who usually dispose of the gum at a very low price to Chinese middlemen who generally ship it to Singapore. The amount exported is in the neighbourhood of 800 to 1,100 tons per annum; the "assessed value" is 10 pesos per 100 kilograms (£1 for 220 lb.). Almáciga resin is used in the production of

[1] H. N. Whitford: "The Forests of the Philippines," Part I.

high-grade varnishes, in microscopy, and for purposes where a very hard varnish is required. There are several commercial grades of this product valued largely according to purity and colour; the clear article, free from bark and dirt, is worth about 12 to 15 pesos per picul (£20 to £27 per ton).

Elemi.—This is a white plastic, or nearly solid, oleoresin, the product of forest trees known as Pili (*Canarium luzonicum*) and Pagsahingin (*C. villosum*). It is collected mostly in Tayabas but it occurs also in Ambos Camarines, Albay, and Sorsogon in southern Luzon; "Brea blanca," or "Brea de Pili," is the local name. Only a comparatively small amount of this resin is exported at present, but when a steady supply can be depended upon it will become a valuable commodity. It is used locally in a crude state, mixed with ashes, powdered charcoal, etc., as a pitch for caulking boats; torches, having a very agreeable odour but a smoky flame, are commonly made from it. On account of its pronounced stimulating qualities it is used in various medical ointments and in surgical plasters. Over 200 tons of Manila elemi are collected annually, valued at about £15 per ton. The produce of a fair-sized tree is said to be about 25 lb. per season.

Manila elemi, while closely similar to Mauritius elemi (produced by *C. paniculatum*), must be distinguished from the unrelated Brazilian, Mexican, and African resins sold under the name of "elemi."

The tapping process is very simple: "Incisions are made in the bark usually at the beginning of the rainy season (June). About once a month the resin is collected and the bark recut. This keeps up till December, when the resin practically ceases to flow for that year."

Other Resins.—There are several other resins which enter into local commerce; some 50 species of the Dipterocarpaceæ alone yield oils, pitches, or resins. "Some of these are encountered in a solid form, others are plastic, and still others harden so slowly that they are removed as fluids. The latter are known as wood oils and bear the local name of the tree from which they are collected. To the former class belongs the resin of yacal (*Hopea plagata*) and guisoc (*Shorea balangeran*). This is collected by making incisions through the bark. The oil hardens to a brittle brownish-black resin and is collected in this form. It is used locally for torches and is often mixed with softer resin for caulking."[2]

Wood Oils.—The principal Philippine wood oils are Balao, produced by several species of *Dipterocarpus* and *Anisoptera*, and Supa, a thin pitch-like oil, produced by a leguminous tree (*Sindora supa*, M. et R.) These wood oils are gathered in a very wasteful manner for local use, and considerable quantities of valuable timber trees are destroyed by the crude methods of native collectors. Cup-shaped incisions are made in the base of the trunk, into which the oil oozes; firing the cut surface greatly increases the flow. About 50,000 litres (over 12,000 gallons) are estimated to be produced throughout the Archipelago; the assessed value is 0.10 peso per litre (1/- per gallon). There is at present no export, these oils being used only by the Filipinos for lighting and, when mixed with other substances, for caulking boats.

Dyewoods.—Only one wood of this class, known as Sibucao, or Sappan wood (*Caesalpinia Sappan*), is of any commercial importance at present. This tree is frequently planted as a timber crop, especially in the island of Panay in the Visayas. Only the bright colored heart-wood is used. Several dye-stuffs are produced in the province of Cavite, but are of merely local importance. Over 1,600 tons of dyewood, mostly from Iloilo province in Panay, were produced in the fiscal year 1913; the assessed value is 11.50 pesos per 100 kilograms (£1 10s. per ton). Besides Sappan wood about 81 tons of dye barks were also produced in the last fiscal year, worth about £5 per ton.

Tan Barks.—Although there is a considerable quantity of this material in evidence throughout the Archipelago, there is no real industry except for local requirements at present. Only about 880 tons were produced in the

[2] H. N. Whitford: "The Forests of the Philippines," Part I.

last fiscal year and the assessed value was only £3 per ton.

Rattan.—There are about 30 more or less distinct varieties of rattans recognized in the Archipelago; these are produced by the climbing palms of the genera *Calamus*, *Daemonorops* and *Korthalsia*. A considerable quantity of this material is used locally in the manufacture of furniture and in tying bamboo sticks in the construction of houses, fences, etc. Only about 3,000 tons per annum are exported, according to the Bureau of Forestry statistics. It is possible, however, that some of this product finds its way into Sandakan and Singapore from Western and Southern Mindanao without the export being recorded. The assessed value is only £10 per ton. The export figure could undoubtedly be trebled very promptly if the price were somewhat increased.

Gutta-percha.—Western and Central Mindanao have for years produced a considerable portion of the world's gutta-percha; on account of the customs of the Chinese middlemen, however, practically all this material has been handled through either Singapore or Sandakan, and consequently the Philippines has not received due credit for the production. Several species of Sapotaceæ, especially of the genus *Palaquium*, usually large trees of the dense forests, are the origin of true gutta. A firm has recently been established on the Rio Grande river at Cotabato and a plant has been erected with facilities for cleaning the raw product and turning out a very high-grade article in cubes and blocks instead of the old balls and twists which frequently contained stones, chips, bark, etc., when they reached the hands of the Chinese merchant. Only about 85 tons were recorded as having been exported during the last fiscal year. The assessed value was £70 per ton.

Rubber.—A few large vines of the forests of the Southern Islands produce genuine caoutchouc, but though sometimes collected by the wild tribes, it is mixed with gutta-percha and is sold at the same price to the Chinese dealers. *Parameria philippensis* is the principal of these vines, and one or two species of

Chonemorpha also yield fairly good rubber. Although scores of thousands of Para rubber seedlings have been distributed throughout the Archipelago during the past five or six years probably not 2 per cent. of them are in evidence at the present time. The fault lies partly in the ignorance of the planter as to the proper methods of handling and partly in the climate, that is, in the long "dry season" droughts which almost every year last for three to six months. In the island of Basilan, south-west of Mindanao, however, one plantation is just beginning to produce a very small quantity of first-class Para. At Lais on the Davao Gulf of south-eastern Mindanao, a small plantation of Castilloa rubber is beginning to turn out a little scrap; it seems that the trees on this plantation have made a phenomenally good growth, the soil and rainfall being precisely suited to the trees, which in about seven years have attained to something like a foot in diameter. In the Province of Albay and Ambos Camarines there are a few very small plantations in some of the richer valleys, but through wrong methods of culture and the aforesaid drought periods, they cannot be considered as even moderately good. Ceara has been planted in several places but practically abandoned as non-productive.

Pili nuts.—Several forms of this nut are known in the Philippines but it seems that most of the export varieties are yielded by *Canarium luzonicum.* In Tayabas three distinct varieties known as Basiad, Tugdugin and Palauay are recognized by the natives; of these Basiad is the best flavoured but most people prefer the Palauay on account of its large size. The outer fleshy covering of the nut is sometimes used by the Filipinos in making a "dulce." On account of the recent interest in the pili as a table nut in the United States some planters are discussing the advisability of planting a few pili trees in their abacá and coconut plantations. It is doubtful, however, whether these trees would bear before 20 years and even than no large crop would be obtained. One bushel per tree is considered by the Bureau of Forestry to be a fair estimate for a good sized tree; this, with the yield of elemi, or resin, brings up the income per tree to some 6/- to 8/-, or, say £15 per acre for 25 to 40 years. The tree seldom exceeds 18 metres (60 ft.) in height. It grows, however, at all altitudes up to 1,500 feet. In the forest they do not average more than one tree to every five acres. In some regions, such as Ambos Camarines, Albay, and Sorsogon, it is very easy for native collectors to bring in one sack of nuts per day. The nuts are worth from 1d. to 2d. per lb. locally. About 900 tons were shipped from Manila in 1913, most of the material being handled by five export companies. The average f.o.b. price in Manila is about £10 per ton.

Lumbang.—Two species of wild or semi-cultivated trees in the Philippines produce this nut, sometimes known as candle-nut and frequently exported from Mindanao as Biao. *Aleurites trisperma* ("Balukanad") appears to be largely confined to the Philippine Archipelago; *A. moluccana*, or true lumbang, is wild or semi-cultivated both in the Davao district of Mindanao and in southern Luzon. The nuts of the two species are very similar both in appearance and properties and the oil of both closely resembles that of the Chinese Tung, or wood oil tree (*A. Fordii*). Most of the lumbang is used locally by Chinese dealers in Manila in the manufacture of soap and in painting cascos, small boats, and lighters to waterproof them, and also for preserving timbers intended for use in water. Estimates of the local consumption of lumbang vary widely; it is probable, however, that not more than 50 tons per year are handled in Philippine markets. The local value is 5 to 8 pesos per picul, say, £8 to £12 per ton. Two or three grades of oil are produced from the kernels, one being used to a small extent in the preparation of paints. The hard shells are removed by women and children and the kernels are then dried in the sun as in the case of copra. In Cavite three grades of the kernels are recognized, the third quality being largely composed of small pieces, more or less rancid kernels, and a certain amount of shell particles. Recent interest in lumbang is causing a few planters to experiment with it as a secondary crop on coconut plantations. Some authorities claim that the tree will bear in the fourth year and that several bushels of nuts (in the shell) are produced by a good-sized tree.

Soap barks.—Though not exported, there is a good steady local trade in Gogo (*Entada scandens*). This large liane which belongs to the bean family, produces gigantic pods, sometimes three or four feet in length. The bark contains considerable quantities of saponin and even the wood can be used, pounded into a coarse pulp, as a soap-making material. The natives, however, do not employ this bark for making soap but for preparing a saponaceous liquid for washing the hair. It is quite probable that soap made from this bark, being practically free from injurious alkalies, could be used in cleaning delicate fabrics upon which ordinary soap would be more or less deleterious.

The bark of *Albizzia saponaria*, known as Sogo-kasai, Pipi, etc., contains enough saponin to make it a possibly exportable product.

St. Ignatius' Beans.—This product is confined to a certain region of the Philippines including the islands of Samar and Leyte and the northern peninsula of Mindanao. Practically all the seeds of this vine, however, are exported from Catbalogan, Samar. The species *Strychnos Ignatii* is said to be even more powerful than its very close relative, *S. Nux-vomica* and to contain even larger amounts of brucin. It is used to a considerable extent locally, the seeds selling for about one centavo (one farthing) each. It is known to possess very active tonic powers and is believed by the natives to be an active aphrodisiac. For a number of years a small quantity of these seeds has found its way into European markets. The vine appears to be impatient of cultivation or even of any attempt to increase its yield.

Marine Products.

Pearl Fisheries.—Though not generally known outside of the Philippines there is in the Sulu Archipelago a really important pearling industry. There are over 50 pearling boats now operating and diving apparatus is beginning to be used. Japanese capital finds these fisheries an attractive field. Mother-of-pearl shell to the value of £35,000 was exported during the fiscal year 1913. The number of pearls actually secured is very difficult to estimate.

Button Shells.—The opening of two factories for making pearl and other buttons in Manila has resulted in a good trade in both the Green Snail or Turban (*Turbo marmoratus*), and Top (*Trochus niloticus*) shells. Besides the heavy local consumption, some 740 tons were exported in the past year (valued at over £28,000).

Window Shells.—Only in the Philippine Islands is the window shell (*Placuma placenta*) used as a substitute for glass in windows. These exceedingly thin, transparent shells are remarkably tough and durable and last for a lifetime with ordinary treatment; they constitute almost entirely the window pane material of the Philippine Islands. They are obtained in Manila Bay and to a certain extent in the Visayas, no less than 5,000,000 shells being used per annum in the city of Manila alone.

Tortoise Shell.—The exports of this material are small, the value during the past year being only £350. There are three marine species, one of which (*Chelone imbricata*) supplies most of the commercial shell.

Trepang.—No less than 63 species of sea cucumbers are found in the Philippine Islands. In the Province of Surigao and adjacent districts of the southern islands the Chinese dealers carry on a very good trade in bêche-de-mer, some four or five distinct varieties being in evidence. About £13,000 worth were secured in 1913, the price per picul ranging from 12 pesos for the common "Yellow Belly" to 80 pesos for the selected "Oe," a large, smooth black sort (*Holothuria atra*), i.e., £20 to £80 per ton. Only desultory methods of collecting this valuable and very wholesome product are in evidence yet.

Shark Fins.—A Chinese and Moro fishery has existed for some years in the Sulu Archipelago, the exports being valued at about £10,000. Singapore and Hong

Kong take the whole output which amounts to 175 to 200 or more tons; the "white," or dorsal fins are worth up to 6/- per lb. in 200 lb. bales. Unfortunately the sharks, which are extremely numerous and cheaply caught around the Sulu Island, are not economically handled; oil from the liver could be obtained in vast quantities and the meat, if dried and ground, would furnish a large amount of excellent fertilizer; the skins (shagreen) are also valuable and in the case of the beautifully marked tiger and marbled sharks (*Stegostoma tigrinum* and *S. marmoratum*) the value is high, passing as "Morocco leather."

Edible Sea Weed.—Especially in the Southern Islands and Western Luzon good edible sea weed is found, and a crude product known as "gulaman" (*Aghardiella* and *Gracillaria* spp.) is obtainable in the markets of the larger cities. This industry is worthy of greater attention.

Isinglass.—Several species of fish occur whcih yield a fair grade of "sounds." Seale[3] estimates that the value of the fish bladders thrown away at the large markets exceeds the value of the fish in the hands of the lake and sea fishermen.

Sponges.—Little has been done thus far to develop the sponge industry of Mindanao and the Sulu Archipelago. Proper methods of gathering and a very small amount of capital are apparently all that is required.

Fish Ponds.—It is not generally known that in the vicinity of Manila there are many artificial ponds in which market fish are raised for local consumption. According to the Bureau of Science the value of these ponds is at present about £600,000. In passing, it may be mentioned that no less than 1,600 species of fishes are known to inhabit Philippine waters and practically all of these are food species. A fair grade of sardines, according to experiments by the Bureau of Science, can be put up locally. Excellent oysters are fairly common and are beginning to be cultivated. The spiny lobster,

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[3] *Phil. Journ. Sci.*, 1911, vol. vi, No. 6.

several shrimps, and a number of edible sea snails are products of considerable local importance.

Ambergris.—A small amount of ambergris is picked up now and then, and in 1912 some 40 lb., worth locally about £800, were exported, presumably to Singapore.

Other Animal Products.

Beeswax and Honey.—Beeswax to the value of over £7,000 was exported, almost entirely to the British East Indies, during the past year. Domesticated bees from Hawaii and Guam have recently been established by the Bureau of Agriculture. Wild honey enters into local trade to a considerable extent but not sufficiently to supply the demand.

Silk.—The Bureau of Science has at present a Philippine race of the Bengal-Ceylon silkworm, and this special breed is so well acclimatized here now that nine broods can be reared in a year. Stringent quarantine regulations have thus far kept out the European diseases and everything appears to be favourable for the success of the industry. The Bureau of Agriculture has introduced numerous varieties of mulberries, some of them being great improvements over the old Spanish variety which until last year was alone in evidence.

Guano.—Both sea-bird and bat guanos are of local importance though it is not likely that any export will be made in the near future. Much difficulty is experienced, however, in obtaining non-leached guano in the bat caves. It is, of course, impossible to control the drip of water; moreover, the bats are liable to leave a cave if any great changes are made in their "roosts."

Birds' Nests.—The province of Palawan could export considerable quantities of the sea swallow nests; the demand in Canton and Hong Kong is always good.

Colugo Fur.—A few hundreds of these beautiful skins are exported, mostly to France, every season. The greyish, brownish, or blackish marbled and mottled hair is very thick, and as soft as eiderdown or chinchilla; it is said to be used principally in making up very handsome, if rather expensive, "boas" for the Parisian modes. The animal itself is rare outside the island of Bohol.

A SHORT REVIEW OF THE LABOUR CONDITIONS AND THE PROVISION OF LABOUR ON THE AGRICULTURAL, MINING AND OTHER ESTATES IN THE NETHERLAND EAST INDIES.

By P. A. Moorrees.

Introduction.

In order to obtain a true conception of the labour conditions on the estates in the Netherland East Indies it is necessary to divide this colony into two regions, viz.:—

(*a*) The islands of Java and Madoera.

(*b*) The other islands of the Netherland East Indian Archipelago usually indicated as the "Outer Possessions."

On the first-named islands the labour conditions are regulated by the general provisions of the civil law, whilst in the Outer Possessions the labour agreements are for the greater part subject to special ordinances.

The supply of labour in the Outer Possessions also differs from that in Java and Madoera. In the last-mentioned islands, in fact, work is carried on exclusively with labourers taken from the native population, whose engagement on behalf of the estates has not in these islands been regulated by law; on the estates in the Outer Possessions on the other hand, labourers of other nationalities are found side by side with Javanese; the number of Chinese on the tobacco estates in the East Coast of Sumatra Residency (Deli) is indeed remarkable.

In so far as the Netherland East Indies are concerned special supervision is only exercised by the authorities in respect of the recruiting of natives of Java and Madoera for labour to be performed on the estates in the Outer Possessions.

The special ordinances in force in the Outer Possessions with reference to labour contracts are of two kinds:—

A.—The so-called Coolie Ordinances.

B.—The ordinance regulating the labour conditions as between employers and employed who have made labour contracts on a basis differing from that provided in the coolie ordinance.

Both kinds of ordinances apply only to those labourers who are engaged by the employer and who do not belong to the native population of the Government division in which the estate is situated. Labour contracts which are made with persons belonging to such population, and labour contracts which have for their object not the labour itself but the produce thereof, as well as contracts which only relate to the performance of odd services, do not fall within the scope of these ordinances, and are subject to the common law.

A.—*Coolie Ordinances.*

(1) *Object of these Regulations.*—The coolie ordinances owe their origin partly to the necessity of giving to the employers in the Outer Possessions security of tenure, i.e., to ensure that during a certain period they would have at their disposal such labour as they were obliged to import from outside, and partly to offer to those engaged in a land which was foreign to them, the necessary protection and assurance of good treatment on the part of the employer.[1]

In virtue of the coolie ordinances, which agree in their main substance, written contracts may be made with labourers not belonging to the native (original) population of the Government division in which the estate is situated, on behalf of agricultural, mining and other estates in the Outer Possessions on the basis of, and subject to, all the consequences of the said ordinances.

(2) *Labour Contracts.*—These may not be made for a period exceeding three consecutive years, and must conform to certain specified conditions and be drawn up according to a prescribed form.

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[1] The Coolie Ordinance for the East Coast of Sumatra, which applies to seven of the sixteen districts of the Outer Possessions where coolie ordinances are in force, is published in the *Official Gazette*, 1889, No. 138.

In so far as they have not been drawn up on the basis of the Recruiting Ordinance in force in Java, they have no force of law until they shall have been registered by the Head of the Local Government within whose jurisdiction the estate on which the labourers have contracted to serve is situated, and no such registration shall take place until after it has been shown through interrogation that the labourers have voluntarily entered into such contract and are duly acquainted with the contents thereof.

In the event of the registration being refused the labourers engaged shall, at the expense of the employer, be returned to the place where such engagement was made.

(3) *Labourers.*—The labourers employed on the estates in the Outer Possessions as contract coolies, i.e., whose labour contracts are governed by the coolie ordinances, number nearly 300,000, of whom there are 183,000 in the Residency of the East Coast of Sumatra (Deli) alone. They are composed principally of Javanese, also to a large extent of Chinese, with a small number of men from various parts such as Atjeh, Nias, West Coast of Sumatra, Timor and Borneo. On the rubber estates many Javanese women are at work.

(4) *Employer's Obligations.*—The principal obligations of the employer are good treatment of the labourers, regular payment of the contract wages, the supply of suitable dwellings free of charge, and proper medical attendance, including all necessary medicines and the provision of good bathing and drinking water.

The employer is also under obligation to return to the place where they were engaged all labourers discharged on the expiration of the contract or whose contract has either been arbitrarily violated by the employer or considered by him as dissolved on account of duly confirmed continual unfitness for the work which they undertook to perform, unless such labourers desire to remain and have received permission to that effect from the Government.

(5) *Obligations of the Employed.*—The labourer is under obligation to perform regularly the work for

which he bound himself, to carry out faithfully all orders issued by the employer or his staff, and to act in every way in conformity with his contract. He may not absent himself from the estate on which he is employed without a written permit, except on free days and when, on account of ill-treatment, he wishes to make a complaint against the employer or his staff.

The number of working hours may not exceed ten per day under the contract.

(6) *Treatment of the Labourer.*—In addition to his material obligations under the contract in connection with public rights, the employer is charged under the coolie ordinance with the proper treatment of his labourers, by which is understood such conduct towards, and intercourse with, the labourers as may be claimed by them as free men. Without good treatment, showing appreciation and respect for his manners and customs, the workman will never feel contented and at home and become part and parcel of the estate on behalf of which he has contracted to serve.

In further explanation of the above it may be added that rough and coarse behaviour towards the labourers, beating, abusing, refusal to listen to and deal calmly with the complaints and requests of the workers, however insignificant such complaints may sometimes appear in Western eyes, punishments by means of ordering the labourer to do disagreeable or dirty work, haggling over wages and other similar persecutions, would all be acts which must be considered as contrary to the requirements of proper treatment under the coolie ordinance.

By acts such as these the employer estranges the labourer, causing the latter to harbour a feeling of revenge towards him which slowly grows to hatred and may lead to serious consequences as the labourer, bound by his contract, cannot leave the estate on which he feels discontented. And if at any time an attack should be made on the employer's staff, the direct cause may have been an ordinary box on the ear or some abusive language, even provoked perhaps by a defiant and improper attitude of the labourer, but the real cause is the long-smouldering discontent which finds utterance in this manner.

In these times of a general uplifting of the native, the planters, if at least they wish to be immune from attack, will do well in their dealings and intercourse with the population to take into account the altered spirit of the Eastern nations.

A knowledge of languages and a tactful behaviour are amongst the requirements which every employer and his European staff should possess. Young and inexperienced assistants should not be placed in positions of independence, and the mode of living of many requires supervision as the moral preponderance of the European over the Eastern races is dependent again on the manner of living of the first-named.

The necessity for good treatment of the labourers is realized by most employers and much is already being done to render the life of the coolies on the estates more agreeable.

On various estates complete sets of native musical instruments (gamelan) are to be found; on others bioscope entertainments are regularly given.

(7) *Wages.*—The wages of the labourers who have made labour contracts on the basis of the above mentioned coolie ordinances vary a good deal.

On rubber estates they amount as a rule to 33 cents per day for men and 28 cents per day for women, if the labour contract is made for the first time. In the re-engagement contracts the men stipulate for an additional 5 cents per day. Besides these payments the trained tapping coolies usually receive a monthly premium of from f. 1 to f. 1.50.

The coolies engaged for the tobacco cultivation, who plant tobacco, earn by this work on an average 60 cents per day. For other work the usual wages of 33 and 28 cents are paid.

In some districts where provisions are exceptionally dear, the contract wages are higher. For mine work also higher wages are given, viz., from 40 to 60 cents per day, whilst all food is supplied in addition, on some estates free, on others at a small charge.

(8) *Advances.*—Advances are paid on all labour contracts when made.

For labourers engaged in Java on the basis of the Recruiting Ordinance, in so far as they are not mechanics or craftsmen, such advances may not exceed f. 15 for the unmarried and f. 20 for the married men, part of which is payable on arrival at the estate.

In all other cases advances are given of from f. 15 to f. 90, according to the length of time for which the contracts have been made.

The contract provides that such advances shall be repaid by means of monthly deductions from the wages, such deductions, however, not to exceed one-quarter of the monthly wage earned.

(9) *Feeding.*—On agricultural estates the employer does not, as a rule, provide all the food for the labourers. The employer, however, generally stipulates in the contract that the wages shall be paid partly in the form of full board, for which, as a rule, not more than 14 cents per day is charged. Most employers, however, only confine themselves to offer the chief article of food, rice, for sale to the labourers at a fixed price.

On mining estates, as a rule, the whole of the food is provided for the mine workers free.

(10) *Medical Treatment and Housing.*—The authorities demand expert treatment by fully qualified European or Native medical men, as well as proper nursing, including nourishment.

Some estates have their own hospital to which a European or Native physician is attached; others send the sick labourers to the Government dispensaries, where the patients, if opportunity offers, can be treated and nursed against payment, but in most cases a number of estates unite in erecting a central hospital. Those suffering from slight leg or foot wounds, as well as those who feel unwell for a day or two, remain in a simple sick ward on the estate, but all other sick patients are sent to the central hospital for treatment and nursing.

Great expense is incurred by a number of employers in the medical treatment of the labourers on their estates; the building and equipment of their hospitals are such that they could easily serve as a model for the best establishments for the sick.

Directions for the building of hospitals and for the housing of the labourers could be given in a general way, but for the arrangements and equipment thereof it would be difficult to provide a model for use on all estates, as the conditions which prevail, such as the habits of the people, the climate of the district in which the estate is situated, the time during which the buildings will have to serve in connection with the nature of the employment, and other factors which might influence such arrangements and equipment, vary widely.

With regard to labourers' dwellings, experience has shown that, in the case of married couples, the method of employing small isolated dwellings intended for one or two families is preferable to the barrack system. In any case each family should be housed in separate rooms of at least 4 by 4 m. In such rooms, instead of one family, three unmarried persons may be accommodated.

Provision should be made for proper water closets, bathing accommodation, good drinking water and separate kitchens, whilst the laying out of fruit and vegetable gardens should be encouraged.

In connection with sanitation, it is advisable, before erecting hospitals and labourers' dwellings, to consult a medical man of some experience, preferably one who has some knowledge of the conditions obtaining in the Residency of the East Coast of Sumatra, where much has been done to meet the requirements in this respect.

In addition to the recruiting charges, the expenses of working with contract labourers may be estimated at an average amount per annum of:

For housing	f. 10
,, medical treatment	10
,, wages	140
,, loss on rice	6
,, supply of tea	1
,, gifts	1
,, writing off debts, etc.	1
	f. 169

(11) *Penal Enactments.*—Any arbitrary violation of the labour contract is punished on the part of the employer with a fine and on the part of the employed with a fine or deprivation of liberty, whilst the latter is further threatened with punishment on account of opposition, insulting or threatening an employer or his staff, disturbance of the peace, excessive laziness, inciting to desertion or to refusing to work, fighting, drunkenness and such like offences against good order.

Finally, punishment is also threatened for encouraging the non-fulfilment of labour contracts or the favouring thereof by housing, or taking into service any labourer who is not free from service obligations towards others, whilst any labourer found outside the estate without permission and without lawful reason is liable to be taken back to such estate, if necessary by force.

B.—*Ordinance regulating the labour conditions as between employers and employed who have made labour contracts on a basis differing from that provided in the Coolie Ordinance (Official Gazette, 1911, No. 540.)*

(1) *Object of the Ordinance.*—In the event of employers in the Outer Possessions taking into their service labourers not belonging to the native population of the Government division in which the estate is situated, on a different basis from that provided in the coolie ordinances, they can only do so in conformity with the provisions of the second section of the ordinance published in the *Official Gazette*, 1911, No. 540.

(2) *Labour Contracts.*—Contracts to be made with labourers in conformity with these provisions are not subject to specified forms and may be made either verbally or in writing, except when the labourers have been recruited in Java on the basis of the recruiting ordinance (see under C. p. 611), in which case the contracts must be written and drawn up in conformity with a specified form. Re-engagement contracts in the Outer Possessions with such labourers recruited in Java may, if desired, be made verbally.

Contracts made under this ordinance, as in the case of the coolie contracts referred to under A (2), p. 602, must be made for a specified period.

The names of the labourers should be entered in a prescribed register, together with the date of commencement and termination of their contract, the wages agreed upon and the indebtedness, if any, of the labourer.

The Authorities do not interfere with the entries or registrations of the names of such labourers, but the register should at all times be open for inspection by the Government Officials concerned and the Labour Inspectors.

(3) *Obligations of the Employer.*—The employer is under obligation to pay the wages regularly to the labourers, and no moneys may be stopped out of such wages except those mentioned in the contract and on no account may such stoppage exceed one-quarter of the wages earned since the last payment of wages.

The employer is also bound to provide his coolies with suitable dwellings, together with proper medical attendance including all necessary medicines, and to supply them with good bathing and drinking water.

Finally, the employer is bound to return the labourer to the place where he was recruited at his (the employer's) expense, on the expiration of the labour contract or on any intermediate date, in the event of such labourer being forced, through physical incapacity to work, to leave his service prior to such expiration, or in the event of his being discharged by the employer through no fault of his own or without any contributing cause on his part.

(4) *Special Penal Provisions.*—Penalties may be imposed for failing to keep, or for not keeping properly the register above referred to, or for refusal to allow inspection thereof by the competent authorities; for a breach of the provision regarding the payment of wages, and for failure to provide housing accommodation or medical attendance; for resistance, insults or threats against the employer or his staff, disturbance of the peace, fighting, drunkenness and similar offences against good order, as well as for encouraging the non-

fulfilment of labour contracts or favouring such non-fulfilment in any way whatsoever.

Apart from the above the dissolution of labour contracts, in the event of either party failing to observe his obligations, is a question of compensation for costs, damages and interests.

C.—*The Supply of Labour on the Estates in the Netherland East Indies.*

(1) *Introduction.*—Administrators of estates situated in Java and Madoera, are free to engage labour both in those islands and in the Outer Possessions, on behalf of their estates, without any permission from the Authorities.

Recruiting in the Outer Possessions for estates situated in Java and Madoera does not occur, as in Java, with its 35,000,000 inhabitants, sufficient labour is always obtainable under certain circumstances, and the local native is preferred as a labourer to all other races.

Natives of Java, chiefly of Central and West Java, on the other hand are much in demand in the Outer Possessions and elsewhere. The population of the Outer Possessions is sparse and the people not always willing to hire themselves out as labourers, as in most cases, on account of the few people and the comparatively large extent of arable land available for them, it is easier for them to supply their small wants in other ways.

Besides recruiting in Java on the basis of the recruiting ordinance (see under (2) below) the employers in the Outer Possessions try to keep a full complement of labourers by making re-engagement contracts with the labourers imported from elsewhere, whose labour contracts have expired.

Such men would have the right of repatriation at the expense of the employer to the place where they were recruited: by offering premiums, advances and higher wages, assurance of a maintenance of the right to a free return and otherwise, it is sought to keep the labourers on the estate.

The re-engagement contracts are made for a period of 1, 2, or 3 years, the amount of the premiums and advances being in proportion thereto. On an average such advances for 1, 2, and 3 years are respectively f. 25, f. 45, and f. 70. The premiums, which, however, are not invariably granted, amount to from f. 5 to f. 45. The advances are deducted from the wages in monthly instalments.

On some estates from 60 to 80 per cent. of the labourers agree to re-engagement. Other labour is engaged on a small scale in the district in which the estate is situated, as well as in a few other residencies of the Outer Possessions and elsewhere, but for the rubber estates such recruiting is unimportant.

(2) *Recruiting on the Basis of the Recruiting Ordinance* (*Official Gazette*, 1909, No. 123).—The recruiting of natives in Java and Madoera for performing labour on behalf of commercial, agricultural, or industrial undertakings and public works in the Outer Possessions was at one time free. It was increasing year by year, and, in order to regularize it and to put an end to the abuses which had crept in, an ordinance was enacted in 1909,[2] according to which such recruiting could only take place with the permission of the authorities. Directions were given at the same time as to the manner in which recruiting might be carried on in the event of permission thereto having been obtained.

In accordance with these directions, the non-fulfilment whereof is a punishable offence, labourers for the abovementioned undertakings, in so far as they are not recruited through the medium of the Public Authorities in the interest of the State, can only be obtained in Java and Madoera through a recruiting office. The manager of such an office, known as the recruiting agent, in order to be able to act as such, must obtain a licence from the head of the district in which he is established. The recruiting officers (Europeans) and assistants (natives) in the service of the recruiting agent must also hold a licence

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[2] The provisions for the execution of this ordinance are contained in the Supplement to the *Official Gazette*, Nos. 6962 and 7232.

granted by the head of the local government in which they reside. Persons not in the service of a recruiting agent cannot obtain a recruiting licence.

All such licences, which are given in writing, are only issued to persons of good reputation. They are liable to cancellation by the authority by whom they were granted in the event of the holder, in the performance of his duties in connection with recruiting, failing to fulfil the obligations imposed upon him, or being guilty of unauthorized acts with regard to the natives concerned.

The engagement of non-adult natives is prohibited; as regards married women, their engagement is only permitted subject to their husbands giving their consent to that effect.

The law imposes upon the recruiting agent various obligations, of which the following are the principal:—

(*a*) The engaged persons to be housed in depots to be erected or fitted up and maintained at his expense, both in the chief centres of the divisions in which he carries on his work, and at the place of embarkation of such engaged persons.

(*b*) All persons housed in such depots to be properly treated, fed, and clothed.

(*c*) Sick persons to be conveyed to a ward or hospital kept separate for such purpose.

(*d*) The engaged persons to be medically examined at his expense to ascertain whether or not they are physically capable of performing the work for which they were engaged.

Before the persons engaged shall be transported to the depot at the place of embarkation they must be in possession of a declaration issued by the authority in the interior where the negotiations regarding the engagement were first opened, as evidence of their agreement with the principal terms of the labour contracts to be concluded with them in any of the three ports of Batavia, Semarang, and Soerabaya.

Embarkation of contract labourers at any other port than the above is prohibited.

No labour contract may be made unless accompanied by a medical certificate, stating that the labourer is physically fit for the duties he has been engaged to perform, as well as by the above-mentioned "declaration."

Labour contracts are not legally effective until the existence thereof shall have appeared from Acts executed before any of the recruiting commissioners residing at Batavia, Semarang, or Soerabaya.

In executing these Acts, which are put in writing in conformity with the specified forms, i.e., for contract labour with penal provisions the forms of labour contracts (*vide* A (2)) fixed by the various coolie ordinances, and for free labour the form referred to under B (2) of this review, the contents of the contracts shall be clearly explained to the natives in their own language by the official before whom such Acts have to be passed, whilst all necessary information shall also be given to them with regard to any consequences of such contracts as may be of importance to them.

Co-operation in the execution of these Acts on the part of the above-mentioned officials shall be refused, amongst other reasons, if it should appear that the labourer has agreed to the contract through fraud or in error, and if serious doubt should have arisen as to the identity of himself or of the members of his family accompanying him.

All expenses of transport, feeding, and nursing of the recruited labourers on board ship are to be paid by the recruiting agent.

As a result of the great demand for Javanese in the Outer Possessions, the number of recruiting offices in Java has increased enormously of late, accompanied by a rise in the cost of recruiting. Whereas about six years ago these charges only amounted to about f. 65 per recruited labourer, in 1913 they had risen to f. 165 per head, to fall again in the course of the year 1914 to f. 125 and f. 130.

(3) *Direct Recruiting in Java.*—Although the recruiting in Java is in the hands of the professional recruiters—i.e., of recruiting agents, who, after having been licensed as such by the authorities, conclude the required labour contracts with the prospective labourers as attorneys of the employers in the Outer Possessions—some employers

have of late endeavoured to free themselves from professional recruiting, which in Java, on account of the abuses attending such recruiting, is unpopular with the natives, expensive in working, and often unable to supply or supplies too slowly the demand for suitable labour. They applied for and obtained a licence as recruiting agents, and themselves managed the recruiting on behalf of their estates. This plan, however, has not so far received much extension on account of the heavy expenses connected with it.

During the last year or two the Deli Planters' Association on the East Coast of Sumatra has also been engaged in recruiting in Java under their own management. This recruiting is done by labourers who have worked for a number of years on the estates in the abovementioned district, and the majority of whom go to Java for some considerable time on leave of absence, being consequently still in the service of the employer concerned. Such labourers act as assistants of the recruiting office established in Java by the aforesaid Association, after having obtained a licence from the authorities, and recruit in Java amongst the members of their family and friends.

This method of recruiting has the advantage that labourers can be recruited from a superior class of people than the wanderers, who are the first to be got hold of by the professional recruiting officers. Moreover, the risk of fraud and misrepresentation is lessened by the fact that the recruiting assistants, knowing that they may perhaps be working afterwards on the same estates as the men now engaged by them, will not so easily resort thereto as the professional recruiting officers, whose relations with the recruits completely cease after embarkation, and who have therefore nothing more to fear from them.

Although the Deli Planters' Association has many difficulties to contend with in this respect, it looks as if their efforts will be well rewarded.

The General Association of Rubber Planters on the East Coast of Sumatra also intend to adopt the above course.

(4) *Recruiting in the Outer Possessions*.—Compared with the number of contract labourers leaving Java, the number of those returning is small. In 1912, for example, 40,243 labourers left Java for the Outer Possessions and only 4,571 returned, whilst 4,947 left for foreign countries and 384 returned. The corresponding figures for 1913 were 32,537 and 4,766, and 2,185 and 569. The reason of this is that many, on expiration of their labour contract, do not make use of their right of repatriation, but accept re-engagements either on the same estate or elsewhere.

The existing estates, in fact, provide themselves in the first place with the necessary labour by making re-engagement contracts, firstly, because by so doing they keep at their disposal labourers suitable for the work and inured to the climate, and secondly, because the great expense of recruiting elsewhere is thereby saved.

Others establish themselves as free labourers, farmers, small traders, or domestic servants in the country to which they emigrated.

It also happens that here and there the native population of the Outer Possessions emigrate from one district to another, and there hire themselves out as labourers on the estates.

On the East Coast of Sumatra, for instance, many Bandjarese (people from the Southern and Eastern Division of Borneo) are found, who are there taken into service by the employers, chiefly for the erection of labourers' dwellings, barns for trade purposes, etc.

From Nias there is a proportionately large emigration to Atjeh and Tapanoeli, where these emigrants are met with on the estates.

Islanders from Timor also allow themselves to be recruited for labour on the estates.

D.—*Supervision of the Execution of the Labour and Recruiting Ordinances.*

The supervision of the execution of the regulations with regard to the mutual rights and obligations of employers and employed in the districts where such regulations are in force is carried out by the Labour Inspection and Coolie Recruiting Service in the Netherland East Indies.[3]

The general supervision is entrusted to the superintendent of the aforesaid service; under his orders there will shortly be sent out two inspectors, of whom one will also act as assistant superintendent of the said service, and twelve assistant inspectors charged with the direct supervision, as well as with the duty of regularly visiting the estates or places where the regulations apply, with the control of the conditions prevailing there, with receiving complaints, if any, from employers and employed, and with reporting thereon.

When visiting the estates they may have the services of native and Chinese interpreters who have been attached to them, and who will assist them where necessary in their conversations with the labourers.

In pursuance of their instructions the assistant inspectors of labour will apply themselves to the study of labour questions and labour conditions within their jurisdiction, and will endeavour, where necessary, to cause improvements to be made in the conditions of labour on the estates visited by them.

They will further endeavour, wherever necessary and practicable, to effect an amicable settlement of any dispute which may have arisen between employer and employed with regard to their mutual rights and obligations.

Reports as to their findings will be forwarded by them to the superintendent of the service, and these will, where necessary, be communicated to the Government with a view to the introduction of any measures or provisions required.

The general supervision also as regards the recruiting of contract labourers on behalf of agricultural, mining, industrial and other undertakings established either in or outside the Netherland East Indies, rests with the superintendent of the labour inspection, and in so far as

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[3] This branch of the service issues Reports, which are obtainable by the public at the Depot van Leenmiddelen, at Weltevreden.

they shall receive instructions to that effect from such superintendent, the other officials of this branch of the service are also charged with such supervision.

The heads of divisional and local government shall further exercise a general control over the fulfilment of the provisions concerning the recruiting of natives in Java and Madoera, the said heads of government in the exercise of such control in the ports of Batavia, Semarang, and Soerabaya being assisted by the Recruiting Commissioners, and, so far as the sanitary conditions in the recruiting depots and the health of the persons housed therein are concerned, by medical officers appointed for that purpose.

The labour inspection officials exercise no judicial functions; they are charged, however, with the investigation of punishable offences in relation to the labour and recruiting ordinances.

Where in the Outer Possessions regulations as to recruiting do not exist, no special supervision, as already mentioned above, is exercised thereon. This, however, does not prevent Inland Government officials being obliged, in virtue of their official position, from seeing that no deception shall be practised with regard to such recruiting. Thus, as a rule, labour contracts of persons recruited in a district other than the residency in which the estate concerned is situated are executed before the Government official of the place of origin of the labourers.

SGUARDO COMPARATIVO DEI SISTEMI DI CONCESSIONE DELLA TERRA NELLA COLONIZZAZIONE CON BIANCHI.

Per il Professore Dino Taruffi.

Gli scopi che si prefigge ed i mezzi con cui si svolge la colonizzazione delle terre, variano secondo i paesi e le loro condizioni.

In rapporto a queste, si possono distinguere tre casi principalissimi, in cui i coltivatori bianchi si trovano ad operare: —

1° Paesi di immigrazione, con larghissima parte di terre libere disponibili per la colonizzazione.

2° Paesi europei, di emigrazione.

3° Infine, e come termine intermedio, paesi di conquista, le cui popolazioni indigene contano già dei diritti riconosciuti ed abbastanza estesi sulle terre.

* * *

Nei paesi nuovi, nei quali i diritti delle popolazioni indigene sulle terre, nel fatto o nel diritto sono trascurabili, si può disporre di riserve immense di terre demaniali, che lo stato può destinare a colonizzazione; difetta invece la mano d'opera.

In questi paesi il capitale, guidato dalle intelligenze dei popoli colonizzatori, apre la strada; ma in compenso reclama la prima parte nella concessione delle terre.

Di quì, un primo periodo, nella storia della colonizzazione delle terre, di concessioni a grandi lotti, concessioni da prima gratuite successivamente onerose, ma sempre a prezzi relativamente bassi.

Ma, dopo che i paesi nuovi si sono incamminati nella via ulteriore della utilizzazione delle loro terre, una distinzione si vede automaticamente delinearsi. Le colonie adatte per il bestiame ricevono incremento e conferiscono impulso alle industrie armentizie; le altre richiamano sempre più largamente i piccoli coltivatori europei.

Tale differenziamento è come una imprescindible conseguenza delle condizioni di tempo e di luogo: l'industria armentizia infatti, date le condizioni dell'agricoltura nel tempo, è l'unica forma conveniente di utilizzazione capitalista delle terre. Dove l'industria armentizia non trova condizioni adatte, non v'è utilizzazione remunerativa che mediante la piccola coltura, mancando i mezzi per esercitare forme diverse di produzione agricola.

I grandi colonizzatori debbono dedicarsi alla divisione della terra in lotti d'estensione limitata, da ricedere ai piccoli coltivatori a prezzi convenienti.

Ma intanto il richiamo di mano d'opra, la necessità e l'utilità di forme di piccola coltura, determina sollecitamente un secondo periodo, specialmente nelle colonie più adatte ad utilizzazione agricola: quello delle piccole concessioni e della formazione di proprietà coltivatrici, come base della politica fondiaria dello stato. Queste piccole impresse assumono forme diverse: generalmente sono concessioni in proprietà assoluta; molto raremente concessioni in affitto a breve e lungo termine; spesso sono gratuite ma, anche se onerose, il prezzo per ciascuna unità di superfice é necessariamente limitato. Col volgere degli anni, si vanno determinando fatti ancora diversi: per le comunicazioni divenute più facili ed economiche, in seguito ai perfezionamenti tecnici dell'agricoltura, questa va subendo una profonda trasformazione: da arte agricola, si trasforma in una vera industria terriera, che richiede la direzione di intelligenze convenientemente preparate, l'aiuto di capitali adeguati.

I nuovi elementi direttivi tecnici non possono essere alla portata del piccolo coltivatore, i mezzi moderni—ed economici nel funzionamento—di coltura agricola, non possono essere messi in azione nelle piccole aziende di proprietari coltivatori; di quì un terzo periodo—il periodo attuale—nella concessione delle terre e nella vita agricola dei paesi nuovi; periodo in cui, accanto alla piccola proprietà, prospera la grande proprietà capitalista.

Grandi e piccole concessioni, grandi e piccole proprietà coltivatrici, si vedono in questo modo promosse e formarsi nei paesi nuovi, non ostante la grande disponibilità delle terre; e le une e le altre si vedono prospere o languenti, non in ragione delle terre disponibili, ma del sistema di agricoltura, più o meno razionale, che viene esercitato e del capitale di cui si dispone.

Essendo abbondante e di basso costo la terra, è il capitale e la maggiore o minor limitazione di questo, che determina: da un lato, il sussistere ed il prosperare della grande proprietà, di fronte alla proprietà coltivatrice; dall'altro, il prosperare od il languire della piccola proprietà costituita.

La costituzione di proprietà coltivatrici nei paesi nuovi, come è stata in passato, seguita a rappresentare oggi pure un ottimo sistema per allettare al popolamento delle terre.

La forme seguita nella costituzione delle proprietà coltivatrici, in virtù delle terre demaniali di cui abbondantemente si dispone, è generalmente la concessione gratuita condizionata.

Le condizioni stabilite si riassumono nell'obbligo del colono di costruire la casa ed abitarla almeno durante tutto il periodo dei lavori campestri, e di mettere gradatamente a coltura il terreno.

Successivamente alle concessioni, una ulteriore opera si va spesso svolgendo in favore dei coltivatori diretti, nell'uno e nell'altro dei due modi seguenti: (1°) con l'aiutare ed incoraggiare la costituzione della piccola proprietà mediante sussidi ed anticipazioni; (2°) col mettere la piccola proprietà costituita nelle condizioni di essere sottratta alle cause dissolventi, e specialmente alla espropriazione per debiti.

Considerata nel complesso, la colonizzazione sussidiata ha dato non buoni risultati, per ragioni varie: innanzi tutto perchè agisce in senso opposto alla naturale selezione che dei coloni dovrebbe potersi fare in ragione dei mezzi e delle attitudini loro; secondariamente attutisce in essi il senso di responsabilità e di iniziativa.

I mezzi protettivi della piccola proprietà costituita e sopratutto *l'homestead exemption* hanno diminuito il credito od altrimenti il senso di responsabilità, facilitando l'esercizio di una agricoltura a limitate anticipazioni.

Ma una tal forma di agricoltura è quella che ha affrettato l'esaurimento delle terre e fatto decadere la piccola proprietà costituita.

* * *

Nei paesi europei le terre sono—nella grandissima prevalenza—soggette a proprietà privata, nelle sue varie forme di grande, media e piccola. In conseguenza di fatti storici ed economici, queste sono talora soggette a vincoli, servitù e diritti che limitano o quanto meno alterano il diritto privato di proprietà; presentano tal'altra difetti materiali di suddivisione e parcellamento, vincolanti a forme difettose di utilizzazione.

Manca dunque, in complesso, la terra libera disponibile per la colonizzazione.

Quanto all mano d'opra rurale, raggiunge bensì generalmente una densità elevata per unità di superfice, ma presenta l'uno o l'altro dei seguenti difetti di distribuzione, che la colonizzazione delle terre mira appunto ad eliminare: o la popolazione rurale, per quanto densa per unità di superfice territoriale, si trova agglomerata nei centri rurali e le campagne sono spopolate; oppure, se densa e ben distribuita in alcuni regioni o parti di regione, si trova eccessivamente rarefatta in altre. Per ottenere la distribuzione uniforme della popolazione in rapporto alla terra, occorre poter disporre della proprietà privata, ed occorre che questa sia libera da vincoli che in qualunque modo ne limitino il pieno diritto, ed ummune da viziosi difetti di divisione.

Di quì la necessità di una duplice azione colonizzatrice: azione indiretta, tendente a render libere le proprietà private; azione diretta, rivolta a convertire queste ultime in piccole proprietà coltivatrici.

La costituzione delle piccole proprietà coltivatrici, per ragioni ovvie, è la metà a cui tende costantemente la azione legislativa in favore della colonizzazione delle terre nei paesi europei.

Ma la proprietà in Europa, diversamente da quanto accade nei paesi nuovi, ha un valore, ed un valore relativamente elevato, che oltrepassa i mezzi a disposizione dei coltivatori diretti; prezzo, contro il quale si infrangerebbe ogni buona volontà di questi ultimi, se lo stato non intervenisse—così come difatti interviene—con due mezzi:—

(1°) Assumendo direttamente l'opera colonizzatrice, nelle terre demaniali di cui dispone, od in terre acquistate appositamente, per ricederle ai lavoratori a condizione di favore (Colonizzazione statale).

(2°) Oppure anticipando ai coltivatori—con modi e forme diverse—il denaro occorrente all'acquisto delle terre, mediante restituzione rateale (Colonizzazione libera).

Nella colonizzazione di stato, le terre oggetto di parcellamento sono innanzi tutto le demaniali, quindi le provinciali, comunali, le proprietà di opere pie ecc. I mezzi con cui lo stato arriva a disporre delle proprietà private, successivamente o tosto occorrenti, sono: l'acquisto libero in seguito a volontaria vendita; l'acquisto all'asta delle proprietà oberate dai debiti; l'acquisto forzato per espropriazione. A quest'ultima forma per altro molto raramente si è ricorsi.

Le terre procurate coi mezzi suddetti, vengono parcellate e cedute generalmente in proprietà, più raramente in affitto: le concessioni, più raramente sono gratuite od in enfiteusi; normalmente sono a pagamento rateale, per un periodo lungo di tempo.

Lo stato in questo modo è l'imprenditore dell'opera di parcellamento, ad analogia di quanto accade nei paesi nuovi, ed allo stato rimane il rischio dell'impresa. Questa, per altro, è compito assai più difficile che nei paesi extra-europei, perchè richiede molta maggiore immobilizzazione di capitale per unità di superfice; perchè i lotti di terreno non possono avere la estensione e non hanno le riserve di fertilità dei paesi nuovi. La maggiore difficoltà consiste nel soccorrere l'opra, tenendo desto lo spirito di intrapresa dei coloni.

La costruzione della casa viene lasciata alla volontà del colono adeguatamente sovvenuto: questi inoltre deve possedere i capitali di scorta occorrenti.

Nella colonizzazione libera, lo stato interviene come sovventore diretto od indiretto. Esso pone i coltivatori in condizione di avere in prestito una quota molto elevata del valore del lotto (fino ai 9/10) da pagare al venditore, all'atto dell'acquisto, con restituzione in annualità durante un lungo periodo di anni.

In questo modo, mentre il venditore può subito percepire l'importo della vendita, il colono è in condizione di acquistare la terra anche disponendo di poco denaro.

Il venditore assume spontaneamente l'opera ed i rischi e lucri del parcellamento: il maggior guadagno proveniente dalla vendita frazionata da un lato, e dall'altro la necessità di vendere a causa dei debiti, sono le cause determinanti del parcellamento stesso. Ma, data appunto una condizione finanziaria generalmente disagiata nel proprietario, il credito non può limitarsi a sovvenire il colono: occorre che aiuti anche il parcellante, perchè questi possa eseguire le necessarie opere.

E poichè le anticipazioni che vengono fatte, ai coloni per l'acquisto, ai venditori per il parcellamento, investono quote molto elevate del valore del fondo (come abbiamo veduto, fino ai 9/10 di tal valore); si comprende la necessità di organi intermediari fra i sovventori ed i sovvenuti, per invigilare tutto l'andamento dell'opera colonizzatrice. In sostituzione ed integrazione di questi organi intermediari, in alcuni paesi, sono andate costituendosi società di colonizzazione, che assumono l'impresa a scopo di pubblica utilità.

Confrontati fra loro i due sistemi du colonizzazione statale e di colonizzazione libera, il secondo dimostra condizioni di innegabili superiorità, per maggior economia realizzata nella attuazione e maggior vitalità delle proprietà costituite.

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Nei paesi di conquista, nei quali esistono già diritti determinati degli indigeni sopra la terra, diritti che non possono essere tenuti in non cale senza pericolo di gravissime conseguenze, si rendono necessari criteri di attuazione diversi dell'opera di colonizzazione. L'esistenza di forti proporzioni di terre demaniali disponibili avvicina questi ultimi ai paesi nuovi; ma, se la terra disponibile non è in proporzioni ed in condizioni tali da supplire ai bisogni del popolo colonizzatore, occorre poter disporre delle terre impegnate dagli indigeni, così come nei paesi europei si procura ottenere a beneficio della colonizzazione la proprietà privata.

In confronto con quanto accade nei paesi europei, si incontra per altro questa molto grave difficoltà: che occorre in precedenza, conoscere esattamente—e non sempre è facile nè semplice—i diretti dei nativi sopra la terra.

Acquistata questa nozione fondamentale, si presenta come più naturale un orientamento analogo, a quello seguito nella colonizzazione libera europea, e cioè:—

(1°) Procurare di liberare le terre dai diritti di uso, servitù ecc. ad analogia di quanto nella colonizzazione interna indiretta.

(2°) Mettere gli indigeni in condizione di vendere ed i coloni in condizione di acquistare la terra in proprietà privata.

Dati gli scopi prevalentemente agricoli che si prefigge la colonizzazione delle terre nei paesi in esame, il passaggio di proprietà può avere di mira tanto la costituzione delle grandi che delle piccole proprietà, secondo che le condizioni di tempo e di luogo determinano piuttosto il formarsi delle une che delle altre.

In quanto riguarda la costituzione delle piccole proprietà, per ottenere un rapido valorizzamento, appaiono opportune provvidenze analoghe a quelle seguite nella colonizzazione libera europea, che nei paesi di conquista sono destinate a maggiori successi, per il prezzo relativamento più limitato delle terre.

NOTE ON THE MANGROVE FORESTS OF BRITISH INDIA.

By R. S. Pearson, F.L.S.

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1.—Introduction.

The ever-increasing demand for tanning agents due to the greater annual consumption of leather, together with the decrease in supplies of some of the best known tanning materials, such as chestnut bark from France and "Babul" (*Acacia arabica*) bark in India, have caused the trade to search for possible substitutes. British India possesses many valuable products, some of which are only used locally for tanning, such as *Cassia auriculata* and *Acacia arabica* barks; *Cæsalpinia digyna* and *Cæsalpinia coriaria*, *Acacia arabica*, *Phyllanthus Emblica* and *Zizyphus xylopyra* fruits and *Anogeissus latifolia* leaves, while Myrabolams obtained from *Terminalia Chebula*, and to a less extent from *Terminalia belerica*, are not only used locally, but largely exported to Europe. Another large group of tanning materials is obtained from the bark of various species of mangrove from the tidal forests of India. Up to the present they have not been exported on a commercial scale to Europe, though large quantities are annually imported into Calcutta from the Sunderbans, and also on a small scale into Rangoon and Moulmein from the coastal forests of Bassein, Tavoy and Mergui. It is with this group of tan barks that it is proposed to deal in the present note.

2.—Species.

The order to which mangroves belong is that of the *Rhizophoreæ*. They form, together with other species, the tidal forests of India and Burma, having a very striking appearance and peculiar character of their own. The trees and shrubs do not generally grow into massive stems, but form short, small to moderate-sized trunks with spreading crowns covered with glossy thick leaves, while the peculiar inverted candelabrum-shaped root system is developed to fix the shrub or tree firmly in the soft mud and to protect it from being uprooted by storms and waves. Further, many species develop aerial roots from their branches or send up "knees" and other excrescences from their root systems in order to obtain air.

The most important species belonging to this order, from the tanners' point of view, are:—

(*i*) *Rhizophora mucronata*, Lam., found in the tidal forests at the mouth of the Indus, on the West and East Coast of India, in the Sunderbans, on the Arakan, Bassein and South Tenasserim Coasts of Burma, and in the Andamans. It is also found in Portuguese East Africa, the Philippine Islands, on the Malay Coast, and in Australia.

(*ii*) *Rhizophora conjugata*, Linn., a small tree generally associated with the above species.

(*iii*) *Ceriops Candolleana*, Arn., is a small evergreen tree found plentifully in the Sunderbans, in Bengal, on the Bassein and Tenasserim Coasts, in Ceylon, and in most tropical coastal forests of Asia, Africa, and Australia. Like *Rhizophora mucronata*, it has a very wide distribution.

(*iv*) *Ceriops Roxburghiana*, Arn., is a large shrub or small dwarf tree found in the Sunderbans, on the Tenasserim Coast, the East Coast of Ceylon, the Andamans, the Malay Peninsula and Archipelago.

(*v*) *Kandelia Rheedii*, W. and A., an evergreen shrub or small tree found on both the East and West Coasts of the Indian Peninsula, in the Sunderbans, Andamans, and Burma.

(*vi*) *Bruguiera gymnorhiza*, Lam., a large tree found in the tidal forests of the Western Peninsula, in the Sunderbans, Burma, the Andamans, Ceylon, and in Tropical Africa and Australia.

3.—Area covered by Mangrove Forests, Yield and Cost of Extraction of the Bark.

It will be seen from what has been said above that the most important species of mangrove have a very wide distribution, being found in the coastal forests of Africa, extending eastwards through India, the Malay Archipelago, and Philippines to Australia. In India, however, though many of these trees and shrubs are found along the coast, it is only in a few localities that the forests extend over large areas of country, in most cases such areas being situated in the estuaries of large rivers; thus the most extensive mangrove forests are to be found on the Arakan and South Tenasserim coasts, the Sunderbans, Andaman Isles, and to a less extent on the Bassein Coast of Burma. It is proposed to deal with each area separately, so as to give a clear idea of the possibilities of each locality.

(i) *Mangrove Forests of the Arakan Coast.*

The tidal forests of Arakan are nearly all situated between the mouth of the Mayu River in the Akyab District and that of the Kaleindaung River in the Sandoway Sub-division, of which quite two-thirds are situated in Kyaukpyu Sub-division, which lies midway between these two rivers. The exact area covered by mangrove forests is not known, but Mr. Hamilton, the Sub-divisional Forest Officer, who is well acquainted with the district, estimates it to be over 2,000 square miles. He has actually surveyed 323 square miles, and estimates the mapped portion to be about one-sixth of the total area. The tidal area is covered by three types of forest. Those at the lowest level contain various species of mangrove, of which *Rhizophora mucronata* and *Rhizophora conjugata* are the most important; the next belt of forest somewhat higher up consists of the same species mixed with a valuable timber-yielding tree, known as "Sundri" (*Heritiera minor*), and finally, the highest areas covered by the tide are covered by pure "Sundri" forests.

In order to arrive at an estimate of yield per acre or for the total area, Mr. Hamilton, after carrying out his surveys, laid out an acre sample plot, in which he felled the mangrove trees and stripped them of their bark, with the result that 6,760 lb., or about three tons of green bark, was collected and 2,500 c. ft. of stacked fuel. From his survey he obtained the following data:—

	Acres
Mangrove forest	101,122
Mixed mangrove and "Sundri" forest	21,512
"Sundri" forest	35,728
Cultivated land	5,798
Rivers and creeks	42,404
Total area surveyed	206,564

Thus the area surveyed should yield about 300,000 tons of green bark and 5,000,000 tons of stacked fuel. As the area surveyed is estimated to be one-sixth of the total, the yield from the mangrove forests of the Arakan Division may be put at 1,800,000 tons of green bark and 30,000,000 tons of stacked fuel. The Divisional Forest Officer, Mr. Walker, gives it as his opinion that as mangroves do not coppice, though the natural regeneration from seed is excellent, it would be best to work the forests by leaving standards as seed-bearers and give the forests a forty years period of rest between each felling cycle. Further, as the above calculations are based on one sample plot covering only an acre, it would for safety's sake be well to reduce the yield by one-third. Working on that basis, with a forty years' felling rotation and a two-thirds yield, the annual sustained yield of green bark works out to 30,000 tons for the whole Division, and 5,000 tons for the area which has been surveyed. These estimates are probably below the mark, inasmuch as the yield has been reduced by one-third of the actuals, and the mixed mangrove and "Sundri" forests left altogether out of account.

While carrying out the work of stripping and collecting the bark the figures of cost were carefully recorded, and it was found that it cost Rs. 15 to cut and strip three tons of green bark, i.e., the yield of one acre. Taking carriage, establishment charges, cutting, stripping, and stacking of fuel, etc., all into account, it is estimated that Rs. 12—15 per ton would be the outside cost of delivering fresh bark at either Sandoway or Kyaukpyu.

The local officers think that labour would be always available, and that extraction and delivery of the bark to a factory could be arranged for with contractors. It is, however, pointed out that owing to the hard nature of the wood and to the difficulty experienced in stripping quickly special instruments would have to be used, while possibly rough wireways might greatly facilitate extraction to the waterways from the interior of the forest.

The most suitable sites for a factory would probably be either Sandoway or Kyaukpyu, as the rivers and creeks converging on these places afford excellent lines of export for the raw material throughout the year, while the British India Steam Navigation Co.'s steamers call frequently at both ports.

(ii) *Mangrove Forests of South Tenasserim.*

The mangrove forests of South Tenasserim occur in the Mergui and Tavoy Districts, especially in the former. The exact area which they cover is not known, though the Divisional Forest Officer, Mr. Pocock, reporting on the subject, describes them as more or less unlimited. A good deal of bark is and has been extracted from these forests, some of which was sent for experimental purposes to the Government Rangoon Tan Extract Factory, which is now closed down owing to the factory site having been originally wrongly chosen and to the plant being out of date and repair.

The cost of extraction of bark in Mergui based on actual experience works out as follows:—

	Rs.	A.	P.	
(*a*) Cost of extraction to Mergui	6	4	0	per ton
(*b*) Wharfage fees	0	12	6	,,
(*c*) Cooly hire for bundling and boat hire from wharf to steamer	3	2	0	,,
(*d*) Shipping charges from Mergui to Rangoon	6	4	0	,,
Total ...	16	6	6	

In this locality the cost of felling and stripping comes to Rs. 6-4 per ton. Mr. Hamilton found that it cost him Rs. 5 per ton to do the same work in Arakan, while the total cost of landing bark in Rangoon works out to Rs. 16-6-6 per ton, as against Rs. 12—15 per ton in Sandoway or Kyaukpyu; in other words, the estimates put up for two different localities by different officials agree very fairly well. There can be little doubt that Arakan and Mergui are the two most suitable and promising areas available for the extraction of mangrove bark and for the preparation of tan extracts in British India.

(iii) *The Sunderbans Mangrove Forests of Bengal.*

The forests of the Sunderbans are situated on the Ganges-Brahmaputra delta, south-east of Calcutta. The chief species of mangrove in these forests is *Ceriops Candolleana,* which is found widely distributed almost throughout the Division, though more particularly in the saline tracts. Here, owing to the proximity of the forests to a large city, the wood is extracted as poles and fuel has a greater value than the bark. It is, however, a fact that the greater number of pieces of mangrove wood destined for the Calcutta market are also stripped of their bark for tanning purposes.

Inquiries made show that about 3,500 tons of the bark are annually imported into Calcutta; further, it is stated that the cost of extraction is relatively high.

It is thought that though a certain quantity of mangrove bark would be annually available from the Sunderbans, owing to the proximity of these forests to a large consuming centre, the prospects of starting a tan extract industry in that locality would be relatively poor, when compared with those existing in Arakan and South Tenasserim.

(iv) *The Mangrove Forests of the Andaman Isles.*

The mangrove forests of the Andamans are found fringing the shores, interrupted here and there by the steeper slopes of the coast, and along the banks of tidal creeks, stretching often for considerable distances inland. The outer edge of the zone of these forests consist chiefly of *Rhizophora mucronata, Rhizophora conjugata,* and *Ceriops Candolleana*, while in the inner and the higher zone *Bruguiera gymnorhiza* is more frequently found.

Mr. Baker, the Deputy Conservator of Forests in charge of the Andaman forests, gives it as his opinion that the labour at present available would be insufficient to cope with the work of extracting mangrove bark, otherwise it would be possible to sell the bark f.o.b. Port Blair at Rs. 21 per ton. This estimate is based on working with convict labour and includes royalty.

Were persons interested in the mangrove bark from the Andamans, the only possible way of working it commercially would be to obtain a concession for extraction from the Middle and Northern Islands and import the labour.

(*v*) *The Mangrove Forests of the Bassein Coast of Burma.*

The mangrove forests of the Bassein District are found between the mouth of the Laumgyi River and that of the Kyonkadun, and also in the Mwedon and Pokweyo forests. The other areas in which mangrove forests are found in this locality are the Kyagon, Ngyputaw, Einme, Sinma, and Bassein Ranges.

From the forests lying between the Laumgyi and Kyondakun Rivers about 5,000 mangrove trees are extracted annually. These trees are stripped of their bark, which is taken to Rangoon via the ports of Pyapon and Begale, where the Irrawaddy Flotilla Co.'s boats call. The cost of extraction of the bark to the above ports is estimated to be Rs. 12-8-0 per ton. The mangrove forests of the other above-named forests are not worked at present, as there is no demand for the bark.

4.—The Value of Mangrove Barks for the Preparation of Tan Extracts.

This note has not been prepared with the object of dealing with the value of the various species of mangrove bark for tanning purposes, but to demonstrate the possibilities of utilizing mangrove bark, and furnishing information as to cost of extraction, quantities available, suitable localities, labour, and local conditions. It will therefore be sufficient to mention some of the more important reports which have been published in the past, and which demonstrate the value of mangrove barks for tanning purposes.

Many reports have been written on the analysis of mangrove bark and mangrove extracts; all of these it would be impossible to mention without dealing with the subject in detail. Amongst the most important publications and correspondence on the subject are: (*i*) A report by Dr. Hooper on certain tannin extracts prepared in the Pyinmana Forest Division, Upper Burma, 1898. (*ii*)

Reports by Messrs. Ribbentrop and Dunstan on a tan extract plant for India, 1901. (*iii*) Dr. Hooper's Report published in the *Agricultural Ledger* of 1902, No. 1, pp. 35-36, which deals with *Rhizophora mucronata.* (*iv*) An article entitled "Mangrove Barks, and Leather Tanned with these Barks from Pemba and Zanzibar," *Bulletin of the Imperial Institute*, 1904, pp. 163-166. (*v*) A Report from the Imperial Institute on Mangrove Extract and Borneo Cutch by Professor Wyndham R. Dunstan, M.A., F.R.S., Director of the Imperial Institute of London, dated June 25, 1908. (*vi*) A Report from the Imperial Institute, dated April 28, 1911, on Samples of Mangrove Extract sent from the Government Tannin Factory, Rangoon. (*vii*) A Note by Messrs. T. Steel and G. Harrison Russel, published in the *Journal of the Society of Chemical Industry* for March 15, 1912, entitled "The Mangrove Bark of North Queensland and the Manufacture of Mangrove Cutch," which deals with *Rhizophora mucronata, Rhizophora conjugata, Bruguiera gymnorhiza, Ceriops Candolleana*, and other species. (*viii*) *Indian Forest Records*, Volume III, Part IV, 1912—"Note on the Preparation of Tan Extracts, with Special Reference to those Prepared from the Bark of Mangrove (*Rhizophora mucronata*)," by Puran Singh, F.C.S., Chemical Adviser, Forest Research Institute, Dehra Dun. (*ix*) A Note entitled "Australian Mangrove Barks," published in Volume XLI of *Tropical Agriculturist*, August, 1913.

The above reports deal nearly exclusively with the value of the bark for tanning, and clearly demonstrate its possibilities and limitations.

5.—Conclusions.

The conclusions arrived at after perusing the available literature on the subject, and having inspected some of the mangrove forests referred to in this note, are that the possibilities of utilizing the bark commercially for tannin extract are fair to good according to the locality selected. Mr. Walker, in reviewing the position of affairs in Arakan suggests forming mangrove reserves which could be leased out to any firm obtaining a concession on payment of royalty on the manufactured product. Were such action taken the lessees would then be secured from interference with their work by private trades, an important point to be considered when contemplating such an enterprise. The terms which the Local Government would grant to such prospective lessees cannot be stated, though, judging from the policy followed in the case of similar concessions for the extraction of raw material for new industries, the terms asked for would probably be very moderate.

FRUIT CULTURE IN THE TROPICS.

By H. F. Macmillan.

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The subject of this paper, though not new to many people, is, I think, of sufficient importance to justify my presenting the following notes to the Congress. That it possesses considerable interest not only for the colonist or would-be colonists, but also for residents of tropical countries, goes without saying. Few products of the soil present greater attractions to the cultivator than fruit, for the prospect of being able to pluck the fruit of one's own orchard, in addition to obtaining a reasonable return on one's capital, has a special charm. Pomology now finds a place in the curriculum of technical colleges in Europe, America, Australia, and elsewhere, and in practice may well be said to be carried to a fine art. So far, however, fruit culture on a commercial scale has attracted but little attention in the tropics, with but few exceptions. Chief among the latter are Jamaica, with its prosperous banana industry, and Singapore, with a flourishing trade in the growing and preserving of pine-apples. In Hawaii Islands also results have shown that pineapple culture for local consumption and export can be made a commercial success.

Fruit Culture in Ceylon.

Hitherto fruit-growing in Ceylon has only been carried on either as an auxiliary means of livelihood or for private consumption, and it is asserted that there is not sufficient inducement to make it a business venture. But if inducements are created, as they may be, there would seem to be undoubted opportunities of developing fruit-growing in Ceylon on commercial lines. The requirements of the colony and neighbouring countries in the way of fruit, either fresh, preserved, or in jams, are large, and should be capable of being supplied cheaper by locally grown produce than by that brought from thousands of miles away and cultivated and prepared by expensive labour.

Good fruits at reasonable prices are always in demand, and considerable quantities could doubtless be disposed of, at all seasons, in supplying the shipping at Colombo, the local markets and private bungalows, or in making jams, jellies, and preserves. The scarcity of country-grown fruits in Colombo is especially remarkable, and in low-country villages the principal fruits usually seen are sour plantains, green thick-skinned oranges, inferior pineapples, bullock's heart, and such-like. Up-country residents are perhaps even worse provided for, except in the dry season, February to May, when tree-tomatoes, passion-fruit, mountain-papaw, and cooking pears are available in limited quantities. In some of the best-cared-for gardens peaches, strawberries, figs, plums, oranges, cherimoyer, and China guavas are more or less successfully grown.

Climatic Conditions for Fruit Culture.

The most influential factor in fruit culture may be said to be climate, as constituted by the normal rainfall and temperature. Most fruits prefer a comparatively dry climate, which favours the development of flavour and keeping qualities. Ceylon possesses both tropical and sub-tropical types of climate, each of which may be divided into wet and dry zones, and should thus be capable of producing a great variety of fruits to perfection, both of tropical and sub-tropical sorts. Nothing can surpass the suitability of the humid districts of the low-country for the purely tropical kinds, as the pineapple, mangosteen, sapodilla, durian, and rambutan. At intermediate elevations with less rainfall the avocado pear, guava, orange, and others thrive equally well, whilst at elevations of from 4,000 to 6,000 ft. the tree-tomato, China guava, mountain-papaw, and passion-fruit grow to perfection. Here also certain European fruits give moderately good crops in the dry season, provided the plants are not over-exposed to strong wind.

Possibilities of an Export Fruit Trade.

The question whether Ceylon is capable of joining the ranks of fruit-exporting countries has attracted private and official attention on previous occasions, and some spasmodic attempts have been made at furthering local interest in the matter. In this connection Dr. Trimen wrote in 1887, in response to an official communication from the Secretary of State for the Colonies: "I do not know if it be true of the Eastern tropics generally, but in Ceylon there is among English people no great liking for tropical fruits, and few consider them in any way comparable with temperate and sub-tropical ones. Hence there is a large import of tinned and bottled fruits of America and England." Conditions have, however, altered much since then. Faster and more frequent steamer services now enable fruits from the Antipodes being landed in London in good condition. The taste for rare tropical fruits has increased, and many that were unknown in England but a few years ago, as the avocado pear, the cherimoyer, mangoes, and others are now frequently seen in Covent Garden, and sold at fancy prices. Though the partiality for European fruits is in many cases justified, many people think that no fruit can surpass or equal in lusciousness a good pineapple, a "suwandale" banana, a mangosteen, a cherimoyer, or a perfect mango. These are the envy of people in less-favoured climes. The pineapple, mangosteen, and cherimoyer have been described as the most delicious fruits in the world, whilst in the estimation of the late Mr. Alfred Russel Wallace, the sensation of eating durian was worth a voyage to the East. If, therefore, the fruit could be eaten in England without the necessity of a long voyage it should be worth a good price.

In supplying fresh fruits to some of the coastal districts and towns of India less favourably situated for fruit culture, there should be opportunities in Ceylon for a local export trade. This might be supplemented by the establishment of a factory in Colombo or Kandy for making jams and preserves and for canning and drying fruits.

Obstacles to Success.

That there are difficulties in the way of pursuing fruit culture in the tropics with appreciable success is only to be expected. But this is the case with every new venture. For instance, the first pound of tea produced in Ceylon cost about £5 to grow and make, while one of the first consignments of fruit sent from Australia to England sold at fancy prices, but freight and commissions landed the owner in a loss of over £50. The pilfering habit of the natives frequently necessitates the picking of fruits in a green and unripe state, which reduces the latter in popular estimation and in price, and therefore checks cultivation. Another obstacle to progress is the system which obtains locally of supplying fruits by the number instead of by weight or size and quality; thus the natural incentive for growers for market is to increase the number rather than the quality of the fruit.

Were fruit-growing, however, to be undertaken seriously and become an established industry in Ceylon, these and other difficulties could doubtless be largely overcome. District fruit inspectors might be appointed, and it would be the duty of these to see to the carrying out of recognized methods of culture, to enforce regulations for packing, transport, and disposal of produce, and report on the first signs of outbreaks of pests or diseases.

What Fruits to Grow.

The number of tropical fruits that are edible is considerable, though those of real merit are comparatively limited. As differences of opinion will always exist as to the relative value of fruits, a fairly exhaustive list is given here for selection. The motto should be to grow a few kinds well rather than many imperfectly. To attempt growing numerous sorts in a cramped area inevitably leads to disappointment and indifferent results.

(1) *For Low and Intermediate Elevations, with Moderate Rainfall.*

Plantain or banana (*Musa paradisiaca*).—By far the most universal fruit grown in Ceylon; in season all the year round. There are numerous varieties, "Suwandale" and "Kolikuttu" being considered the two best. Second-rate varieties, as "Embul-hondaruwala," are the most cultivated, being more prolific and easier grown.

Mango (*Mangifera indica*).—The fruit *par excellence* of India. Found under a great number of varieties, of which the "Rupee Mango" is the largest and one of the best grown in Ceylon. A rather dry climate suits the tree best. Usual season May and June, but earlier at lower elevations.

Pineapple (*Ananas sativus*).—Numerous varieties are known, one of the largest and best being the "Kew Pine" or "Smooth Cayenne," which has spineless leaves; grows up to 5,000 ft. elevation under favourable conditions. Principal season: May to August.

Mangosteen (*Garcinia Mangostana*).—A moderate-sized tree, the delicious fruit of which is usually in season from June to August, or earlier at the lower elevations. The tree is of slow growth, and does not usually bear till eight or nine years old. Thrives in moist districts up to 1,500 ft. The fruits are usually retailed at 75 cents to 1 rupee per dozen.

Durian (*Durio zibethinus*).—A handsome lofty tree, celebrated for its large edible fruits, which are characterized by a disagreeable odour. Season: July and August.

Orange (*Citrus Aurantium*).—There are innumerable varieties of the local "Sweet Orange," most of which luxuriate in the low-country. The sourer kinds are suited for making marmalade, and could be grown in large quantities for this purpose. A rather dry climate, with irrigation, produces excellent fruits. The "Washington Navel" and other grafted varieties do best at the higher elevations.

Rambutan (*Nephelium lappaceum*).—A large spreading tree, the curious burr-like, yellowish-red fruits of which contain a pleasantly acid, white aril round the seed. Season: July and August.

Sapodilla (*Achras Sapota*).—A small, slow-growing West Indian tree, introduced into Ceylon about 1802;

fruit dark brown, about the size of a peach, with soft luscious pulp when fully ripe. Thrives up to 1,000 ft.; a first-class dessert fruit, well worthy of extended cultivation.

Papaw (*Carica Papaya*).—A small, quick-growing herbaceous tree; the large melon-like fruit, always in season, is very refreshing and wholesome. In the unripe state the copious milky juice is rich in pepsin, for which the fruit is recommended for use as a vegetable, being cooked and served like vegetable-marrow.

Breadfruit (*Artocarpus incisa*).—A very handsome, quick-growing tree, with large, deeply cut leaves and oblong green fruits of the size of one's two fists.

Uguressa (*Flacourtia Ramontchi* var. *Cataphracta*).—A thorny, bushy tree of Malaya, producing large berries which are purple or dull red when ripe; they are a pleasant dessert fruit, and make excellent jam.

Kamaranga (*Averrhoa Carambola*).—A low, slender-branched tree, bearing a profusion of peculiar winged fruits, which are very juicy, though sour. Some varieties, however, are sweet and worth cultivating as a dessert fruit.

Cochin Goraka (*Garcinia Xanthochymus*).—A small, ornamental, cone-shaped tree, with large leathery leaves and attractive yellow apricot-like fruits, which are very acid, but refreshing; the yellow pulp is suited for making jam.

Soursop (*Anona muricata*).—A small tree, with large green kidney-shaped fruits of a sweet sub-acid flavour.

Bullock's Heart (*Anona reticulata*).—A small bushy tree, the large heart-shaped fruits of which contain a white granular pulp, which some people relish. Seasons: January, June, and October.

Custard Apple (*Anona squamosa*).—A small tree; fruit roundish or heart-shaped, with projecting scales, enclosing sweet, custard-like pulp.

Avocado Pear (*Persea gratissima*).—A small tree, with large pear-shaped green fruits, containing a large round seed in the hollow centre. The greenish-white pulp (pericarp) is agreeable and wholesome, though more palatable when flavoured with vinegar, etc. Said to be much in favour in America. Principal season: July and August.

Guava (*Psidium Guyava*).—A shrubby tree, introduced into Ceylon by the Portuguese, and now quite naturalized. Thrives in a wild state at all elevations up to 4,000 ft. The better varieties are worth introducing and cultivating for making jellies or jam.

Pomegranate (*Punica granatum*).—A shrubby tree, the best varieties of which are commonly cultivated in the Mediterranean region for their large globular fruits; the scanty but juicy and astringent pulp surrounding the seed varies from sweet to acid and bitter, according to variety; it is commonly eaten for its medicinal properties. Thrives at almost all elevations in Ceylon.

Brazil Cherry (*Eugenia Micheli*).—A small tree with bright red tomato-like fruits, which are acid and slightly aromatic; probably suited for making jellies and preserves.

Rozelle or Rata-bilincha (*Hibiscus Sabdariffa*).—A small annual shrub, with fruits enclosed in fleshy distended calyces, which are bright red when ripe; suited for making jams and jellies.

Rose Apple (*Eugenia Jambos*).—A medium-sized tree, with white and rose-tinted and scented fruits of the size of a large hen's egg; the pulp is snowy white, sweet but rather juiceless. Season: May and June.

Star Apple (*Chrysophyllum Cainito*).—A large, handsome tree, with dark-green leaves; fruits round, milky when unripe, similar to small sapodillas. Season: February and March.

Loquat (*Photinia japonica*).—A small Japanese tree of the apple family, bearing a profusion of sweet-scented flowers, followed by yellow fruits resembling a crab apple. Superior varieties are well worth growing.

Ket-embilla or Ceylon Gooseberry (*Alberia Gardneri*).—A small shrubby tree of Ceylon, with purple velvety fruits, full of slightly acid pulp, not unlike gooseberries; suited for making jams and preserves; well worth growing, especially with a view to improvement by selection and high cultivation.

(2) *For the Higher Elevations, say from* 3,500 *to* 6,000 *ft.*

Tree-tomato (*Cyphomandra betacea*).—A small herbaceous tree, introduced into Ceylon in 1884, and has become a valuable acquisition for up-country; bears a heavy crop of fruit almost throughout the year, if planted in fairly sheltered situations; it is known in the West Indies as "Vegetable Mercury," owing to the action of the fruit on the liver.

Cherimoyer (*Anona Cherimolia*).—A small tree, introduced into Ceylon in 1884; the fruit is considered to be one of the most delicious known, and resembles a custard-apple in appearance, but is much superior to that in flavour. Deserves to be widely known and cultivated. Season: October to December.

China Guava (*Psidium Cattleyanum*).—A small smooth-barked tree, producing heavy crops of claret-coloured agreeable fruits, which may be used for dessert or for jams and jellies.

Persimmon (*Diospyros Kaki*).—A small tree, which bears one of the most noted fruits of China and Japan; not yet generally established in Ceylon, but has been found to thrive and bear fruit in some hill gardens.

Passion-fruit or Sweet Cup (*Passiflora edulis*).—A perennial climber, introduced from Brazil, now growing commonly up-country in a wild state, and cropping abundantly twice a year. The fruits are slightly fragrant, and contain a pleasant juicy pulp. Usually sold locally at about Re. 1 per hundred; often sold in Covent Garden Market at a shilling or more per dozen, being imported from the Canary Islands.

Strawberry (*Fragaria vesca*).—Grows from 4,000 ft. upwards, and in the dry season produces good crops of fruits, which are of moderate size and flavour. Sometimes sold in Nuwara Eliya at 75 cents (= 1s.) per pound. The common wild strawberry of England has become quite naturalized in Ceylon, growing in a wild state in the Nuwara Eliya district.

Cape Gooseberry (*Physalis Peruviana*).—A small creeping, semi-woody bush, with a berry enclosed in a balloonlike calyx; its pleasant sub-acid flavour suggests an English gooseberry; easily grown, and now naturalized about Nuwara Eliya and elsewhere. It is well worthy of extended cultivation, being excellent for dessert, and is one of the best fruits known for making jam or preserve.

Mountain Papaw (*Carica candamarcensis*).—Similar to the low-country papaw in appearance, but the leaves are smaller and coarser; the fruit is only about one-eighth the size of the latter, but is pleasantly scented, and is good for stewing.

Peach (*Persica vulgaris*).—Grows freely in sheltered situations at 4,500 to 5,500 ft., preferring a rather dry climate; in favourable seasons it gives good crops of fruit of moderate quality.

Fig (*Ficus Carica*).—This well-known fruit tree thrives in Ceylon at 5,000 ft. and upwards and bears heavy crops, but the fruit is rather juiceless and insipid, and usually fit for stewing only. Principal season: April to June. The variety "Black Asiatic" has been found the best suited to Nuwara Eliya.

Plum (*Prunus domestica*).—So far only very few varieties have been found to succeed to any extent, these being chiefly the "Blood," "Redheart," "Ootacamund," and "Japanese Yellow."

Blackberry (*Rubus fruticosus*).—A straggling prickly climber; has been grown successfully for many years at Hakgala Gardens (elevation 5,800 ft.), where it fruits freely in May and June.

Ceylon Blackberry (*Rubus moluccanus* var. *macrocarpus*).—Indigenous to Ceylon, common from 3,000 to 5,000 ft.; the fruit is large and juicy, and when ripe has a good flavour.

(3) *For the Dry or Semi-dry Zones.*

Grapes (*Vitis vinifera*).—Certain varieties are grown in the dry climate of Jaffna with very fair success. More productive and better flavoured kinds would no doubt be found to thrive if given a good trial.

Orange (*Citrus Aurantium*).—Fruits of excellent quality can be produced in the semi-dry zone, especially if irrigated and properly cultivated.

Musk Melon (*Cucumis Melo*).—An annual creeper, with large, globular, luscious fruits; should be a valuable acquisition, and thrive to perfection in a semi-dry climate with good soil.

Date Palm (*Phœnix dactylifera*).—This tall feathery palm, so extensively cultivated in Northern Africa, Western Asia, etc., has not yet become established in Ceylon. In the countries where grown the well-known fruit is a standard article of food with the inhabitants, as well as of animals, and forms a considerable article of export. Numerous varieties are known.

Carob or Locust-bean (*Ceratonia siliqua*).—A small tree, specimens of which have been grown at various elevations in Ceylon, but it has not yet become established here as a fruit tree. Extensively cultivated in the Mediterranean region for its sweet sugary pods, which form a considerable article of export, being a nutritious cattle food, and also largely eaten by human beings.

(4) *Nut Fruits suited to Low Elevations.*

Butter Nut (*Caryocar nuciferum*).—A lofty South American tree, producing a large round fruit which contains several hard-shelled nuts (the seeds), said to be the most delicious of the nut kind. Suited to the moist low-country.

Brazil Nut (*Bertholletia excelsa*).—A tall, handsome tree of Tropical America, with large globular fruits which contain the hard-shelled "nuts" or seeds; considerable quantities of the latter are exported from South America, and are the well-known Brazil nuts of commerce. Suited to the humid low-country. Thrives in the Royal Botanic Gardens, Peradeniya, where it produces fruit annually.

Cashew Nut (*Anacardium occidentale*).—A shrubby tree, naturalized in the low-country of Ceylon, where it is found in abundance. The edible kernel (seed) is of an agreeable nutty flavour, and is said to be in much demand in Europe for confectionery.

Queensland Nut (*Macadamia ternifolia*).—A medium-sized tree, with brown, marble-like nuts of an agreeable flavour. Suited to elevations between 2,000 and 4,000 ft.

Java Almond (*Canarium commune*).—A very large tree, with numerous damson-like fruits, produced in large clusters in great abundance. The kernel resembles sweet almonds in flavour. Thrives in the low-country up to 2,000 ft.

AGRICULTURAL SANITATION IN THE GOLD COAST.

By W. H. Patterson.

Government Entomologist, Gold Coast Colony.

In presenting these few notes no attempt is made to offer observations regarding the general sanitation affecting such insects as mosquitoes and tsetse-flies, nor to discuss the relative health of the colony as affecting Europeans compared with other parts of the Tropics, nor is it possible to give results of research work; but the idea is to raise the question of the wisdom of allowing the growth of industries to exceed educational control. What is meant can perhaps be clearly seen by the cocoa industry of the Gold Coast Colony. This cocoa industry, though as yet not out of its infancy, has had a most remarkable development, and the following figures will explain its present value:—

Year		Quantity		Value
1903	...	5,104,761 lb.	...	£86,250
1904	...	11,451,458	...	200,025
1905	...	11,407,608	...	186,809
1906	...	20,104,504	...	336,268
1907	...	20,956,400	...	515,089
1908	...	28,545,910	...	540,821
1909	...	45,277,606	...	755,347
1910	...	50,692,949	...	866,671
1911	...	88,987,324	...	1,613,468
1912	...	86,568,481	...	1,642,733
1913	...	113,239,980	...	2,489,218

It will be seen that the increased output for 1913 is 26,671,499 lb., 38 per cent. over that for 1912, with a value increase of £846,485, or 51 per cent. Whilst half of this increase is due to the late season, the balance is credited to an increased bearing area, i.e., new farms coming into productivity.

The Annual Report of the Agricultural Department for 1912 contains the following significant statement: "Already signs are everywhere apparent that there is grave danger of the farms being extended beyond what might be reckoned reasonable limits, resulting in neglect or inability to maintain the plantations in a clean and healthy condition, thereby threatening the whole industry with disaster."

To understand the position fully it is necessary to know that the cocoa industry is entirely a native or peasant one; that it is impossible to give the acreage at present under this crop, as the farms are small, varying from a few trees to at the most fifteen acres, and, to add to the difficulty, many farms are hidden away in the "bush." The farms are made by cutting and burning the original forest or by clearing the "bush" from between wild oil palms. Seed is sown, and the land may be intercropped with food crops, such as yams, tannias, and cassava, or, unfortunately, the "bush" may be allowed to grow again almost, if not entirely, uncontrolled until such time as a stray cocoa flower may be found upon a plant severely handicapped for existence in its infancy. Seed is sown much too thickly, varying from 4 ft. by 4 ft. to 12 ft. by 12 ft., which latter distance is the best, save in few instances where an exceptionally good patch of soil is found. This neglect of the trees in the early stages is the cause of the greatest loss due to what is known in the vernacular as "Akate" or "Sankonuabe," i.e., to the ravages of two species of capsid bugs, *Sahlbergella singularis*, Hogl., and *Sahlbergella theobroma*, Dist.

The life-histories of these two bugs are not yet completely worked out, but appear to be briefly as follows: The cylindrical, pearly-white eggs are laid for the most part singly, embedded in the woody tissues of branches ranging from $\frac{1}{4}$ to $1\frac{1}{2}$ in. in diameter. They are $\frac{1}{25}$ in. in length, and it is difficult to locate them, as only two short white hairs project into the air. Incubation occupies from fourteen to twenty-one days. Feeding is done during the evening, night, and early morning, and ceases as soon as the sun becomes hot, though during dull and wet days it may continue throughout the greater part of the day. The insects remain almost motionless during the day and are not easily detected, being much the same colour as the bark. They are often in groups on the under sides of the branches, but isolated specimens may be seen in leaf axils. All branches, from soft, herbaceous shoots to those of 2 in. in diameter, are used as food. The shoot is pierced and the sap extracted. The cortex and cambium in the area pierced turn brown and die. When young branches are attacked the sucked spots sink slightly, producing a somewhat gnarled appearance. In dry weather, when many wounds have been made, the leaves turn brown and wither, and the branch is easily bent over with the wind. Should the weather be moist very few branches are broken, and the presence of the insects is overlooked until very severe damage is done. The epidermis in a few days dries up round each puncture and splits open. Gumming takes place and may continue for some time. Where many wounds have been made together, but so that small spaces are left between the sucked areas, the work of healing is left to isolated strands of cambium. It is the result of the after activity of the cambium in attempting unsuccessfully to heal over the dead parts, which since 1909 has been described as canker or dry canker. Young trees may suffer so much that all top growth is killed, and has to be renewed from basal suckers, often delaying the fruiting period for as much as three years. Even when the damage is less severe the after crops are much reduced, as there is so much less vegetative activity in the trees, and the distribution of manufactured products impeded, for the punctured sites never completely heal over. Food plants of the insect other than cocoa have not yet been found, nor has any effective natural control yet been hinted at.[1]

When a farm has successfully reached the age of production, the so-called "cocoa mosquito," *Helopeltis* sp., may take its toll. From recent work performed here it has been found that the effect of this insect may be very severe, as one female made eighty-four punctures in a pod in

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[1] Since this paper was written Mr. Patterson has found that the kapok tree (*Eriodendron anfractuosum*) is a food plant of "Sankonuabe," and in order to reduce the numbers of the pest it is recommended that all kapok trees in the neighbourhood of cocoa plantations should be destroyed. (See *Rep. Agric. Dept Gold Coast*, 1914, p. 22.)—[Ed.]

fourteen hours, whilst a pair made 264 punctures in two leaves of *Acalypha hispida* in twenty-four hours. "Cocoa mosquito" may attack young herbaceous shoots, destroying these, and it may attack the pods. Young pods may be destroyed, though the larger ones may pull through, provided brown pod disease (*Diplodia cacaoicola*) and the grey moth borer of pods (*Characoma stictigrapta*) do not also attack. This Helopeltis breeds on red guava (*Psidium pomiferum*) and its white variety, and on capsicum, both of which are widely distributed throughout the colony. The range of food plants is a wide one, and embraces *Psidium cattleyanum, Aralia Guilfoylei, Panax fruticosum* and vars. *dissectum* and *victoriæ, Solanum Wendlandii, S. seaforthianum* and *S. melangena, Physalis peruviana* and *P. minima, Datura Metel, Spondias lutea, Mangifera indica, Punica granatum, Artocarpus incisa* and *A. integrifolia, Acalypha hispida* and *A. Wilkesiana, Musa Cavendishi, Eriodendron anfractuosum, Piper nigrum* and *P. Cubeba, Bixa orellana, Sterculia Barteri, Ipomoea Batatas, Ilex paraguayensis, Camellia Thea, Paullinia pinnata, Thespesia populnea, Dioscorea* sp., *Persea gratissima, Terminalia Catappa, Michelia Champaca, Euphorbia* sp., and *Leea* sp.

Both Sahlbergella and Helopeltis would yield doubtless to treatment, such as spraying with kerosene emulsion, but there are reasons why such a method of control has made no headway since the discovery of these pests in 1909 by Messrs. Dudgeon and Evans. Among these must be mentioned (1) the pessimistic attitude of the native as shown in "Sankonuabe," which means somewhat like "Let the land go back into oil palms," it being difficult to grow cocoa according to his ideas; (2) the great labour involved in spraying with ordinary knapsack sprayers when the operator has to pump and direct the liquid at one and the same time; (3) the labour of bringing water from a distance; and (4) the cost of kerosene and the absence of any suitable local oil.

"Sankonuabe" alone appears to be responsible for a loss of 25 per cent. of the possible output of cocoa, whilst it is not yet possible to estimate the damage done by Helopeltis, which at the present time is stated to be widely distributed. In addition to these pests, much damage is done by two thread blights (*Marasmius scandens* and *M. equicrinus*), by brown pod disease (*Diplodia cacaoicola*), black pod (*Phytophthora Faberi*), and in 1913 true or "wet" canker due to *Nectria theobromæ*, Massee, was diagnosed from a number of widely separated districts. Notice is not here taken of coleopteron and lepidopteron stem borers, as at the moment these are making no headway; but squirrels, rats, and white ants all harass the farmer, should the foregoing not be a sufficient array of enemies. Yet the statement already quoted from the Annual Report of 1912 is apparently amply warranted, for farms are hardly touched save at the reaping seasons, pods are left on the surface of the soil, pruning is done with cutlasses in a most crude manner, and snags and gashes are abundant, dead and decaying wood plentiful, and tar, as an antiseptic dressing, almost entirely absent. With the possible spread of canker one almost dreads to anticipate the results.

Nor is the danger confined to cocoa, as there is no reason why coconuts should not be planted on a large scale, possibly in conjunction with cocoa; but in one small plantation as many as 200 adult rhinoceros beetles were captured in fourteen days, and palm weevils are very abundant. With the heaps of cocoa pods everywhere, the recent researches of Mr. R. W. Doane in Samoa point to immediate injury to coconuts, should such be started in the Gold Coast without adequate restrictions to control the plantations.

Again, with the Para rubber industry, there is menace from two serious fungoid diseases—*Fomes semitostus* and *Hymenochæte noxia*. These have been noted in European-managed rubber plantations and promptly treated, but Para is being extensively planted by native farmers with their cocoa, and there is reason to fear that should such diseases make their appearance they may not be effectively treated.

To cope with agricultural education, conduct experiments, arrange model plots, and supervise the work of school gardens, there is at the present time a staff of eleven European officers, assisted by six native travelling instructors. Looking more closely into the case, it is found that of the eleven European officers one is devoted entirely to administrative duties; one to specialized work; one stationed in the Northern Territories—where the rainfall and humidity do not permit of the cultivation of cocoa—fostering a cotton industry, and conducting experiments in the rotation of food crops; four are in charge of large agricultural stations, where the duties are such as to allow of no time being devoted to itinerant instruction. This leaves only four officers for itinerant instructional work and for relief of station officers during their annual leave of absence from the colony. Of the six native travelling instructors, two are engaged in conducting sub-stations, and are not able to travel more than fourteen days per month.

Owing to the close system of planting adopted by the native farmers and the present negligent methods of conducting their farms, it would appear as if the average life of the farms would not exceed twenty years, a very short life for cocoa, added to which there are the grave dangers for the future from the establishment of many diseases and the destruction of much forest land, thereby making the future growth of cocoa a matter of probable difficulty from lack of humidity and organic matter in a country where animal manure cannot be obtained, and the value of green-dressing crops has yet to be discovered. Though there is much difficulty in obtaining European officers, and the mercantile community absorbs the most promising of the native officers, yet it has, I think, been clearly shown that there is an urgent and most pressing need for men to carry out the ordinary tropical agricultural sanitary measures as employed in other colonies, and to meet the demands the following measures are suggested:—

(1) The establishment of a staff of European inspectors of cocoa farms, to examine farms, supervise the work of native travelling instructors, and the work of school gardens.

(2) Considerably augment the staff of native travelling instructors.

(3) The establishment of a large number of model plots,

say at distances of not more than five miles apart. (This has been initiated on a small scale, the men in charge being given a few weeks' instruction before taking up the work.) Such plots need not be of considerable size, and could be as small as would carry 200 trees.

(4) The starting of communal spraying outfits in conjunction with model plots. Sprayers should take some form of pneumatic machine, and stock solutions of insecticides and fungicides should be supplied at cost price.

(5) The awarding of prizes for well-conducted farms in various districts.

(6) Encouragement to be given to schoolmasters to become local experts.

(7) The adoption of legislative measures for neglect if necessary. Care must be taken that advisory officers are not employed to carry out such measures, for by so doing their work would be heavily discounted.

(8) The adoption of control factories for fermenting, curing, and shipping of cured cocoa.

(9) The utilization of the numerous large school gardens in which as yet too much attention is bestowed upon the manual work to the detriment of the education side.

(10) The furnishing of all schools in cocoa-growing districts with coloured wall illustrations of the pests and diseases, the evils of bad pruning, the types of good pruning, together with actual specimens. At the same time illustrations of mosquitoes, etc., could also be presented, for it must be remembered that it is a good investment to devote special attention to the schools, as it is from this rising generation that improved farmers are to be expected.

COFFEE-LEAF DISEASE (HEMILEIA VASTATRIX, B. ET BR.) IN UGANDA.

By S. Simpson, B.Sc.
Director of Agriculture, Uganda.

WITH A NOTE ON THE PRESENT POSITION

By W. Small, M.A., B.Sc.
Botanist to the Department.

Botanists appear to agree that coffee is indigenous to Abyssinia and the Sudan, and if not actually in Uganda, it must have been introduced a very long time ago, as wild coffee trees (*Coffea robusta*, Linden) are scattered throughout the Buganda Province in small lots of about five to ten trees, and moreover, the early explorers, Speke and Grant, mentioned its existence. These wild trees receive practically no attention beyond picking the fruit when ripe.

There can be no doubt that the coffee-leaf disease has been present in the country for many years. Sir George Watt, in his "Commercial Products of India," refers to its existence in the Victoria Nyanza region, whilst Sadenback, in "Einige Beobachtungen und Bemerkungen über die durch *Hemileia vastatrix* verursachte Blattflecken-Krankheit der Kaffeebaume" (*Forstlich-naturw. Zeitsch.*, iv, 1895) and M. Hennings in *Zeitsch. trop. Landwirtschaft, Der Tropenpflanzer*, Nos. 5 and 8, 1897, both refer to its existence in this region many years ago.

Old residents were well acquainted with the disease and called it "native coffee-leaf disease," under the impression that it was not *H. vastatrix*, B. et Br., and that it had been identified at Kew some years ago as something different.

When *H. vastatrix* had been recognized in British East Africa the matter was carefully gone into in this Protectorate, where coffee growing is receiving the serious attention of planters, and all European estates were visited.

H. vastatrix was discovered in many cases, and always where some indigenous coffee suffering from *H. vastatrix* was found in the vicinity. A very careful examination was made of the disease on both cultivated and indigenous coffees, and no difference was observable, and having seen *H. vastatrix* B. et Br. at Durban some years ago, I was able to identify both as *H. vastatrix*.

Kew, however, said that the indigenous coffee was suffering from *H. Woodii*, but after further work had been done on the subject, the *Kew Bulletin* No. 5 of 1913, p. 170, confirmed my original diagnosis by stating that "The chief result of the examination of the various type specimens is therefore the establishment of the fact that there is no record of coffee being attacked by any species of *Hemileia* other than *H. vastatrix*."

Treatment was taken in hand immediately, and it was recommended that where the trees were badly affected they should be uprooted and burned.

In other cases diseased leaves were picked and burned, and the plants sprayed with either Bordeaux or Burgundy mixtures. Wind breaks and light shading were also recommended.

Note by Mr. Small.

The source of infection was and is most likely the disease as it occurs on native coffee. Experiments have been conducted to determine this point. These are incomplete and will be continued, but so far results have been of a negative kind. In other words, spores of *Hemileia* from leaves of *Coffea robusta*, Linden, have failed to infect leaves of cultivated coffee. Transport of *Hemileia* spores is easily accomplished. Inquiries made in Uganda have shown that the most frequent agency in the spread of infection from one place to another, or from one part of an estate to another, apart from natural agencies such as the wind, has been native labour.

The drier weather of 1913, especially towards the end of the year, arrested the progress of the leaf disease, and at present—before the onset of the April-May rains of 1914—many of the estates which were seriously ravaged by the disease are able to show masses of fresh new foliage, new shoots, and prospects of good crops.

Should this state of affairs be repeated frequently, and should *Hemileia* be less virulent than before, it is justifiable to conclude that the original severity of the outbreak of leaf disease is not to be of great duration, and that succeeding years may see coffee estates comparatively free from disease. Again, the disease being endemic, cannot be expected to work the havoc that it wrought in Ceylon.

Experiments with sprays and powders have been conducted. Sulphur and lime used as a powder, and various solutions of salt and lime in water used as a spray, have given disappointing results. The best results have been got from the use of Bordeaux and Burgundy mixtures. These are suitable for use at any time, and particularly before the onset of wet weather, as a necessary preventive measure.

The behaviour of *Hemileia* is essentially that recorded from other parts. Infection takes place readily. The atmosphere in most parts is humid overnight, heavy dews are usual, and the temperature is seldom low enough to hinder germination. Disease spots on the leaf may number over one hundred, or be so numerous as to conceal entirely, with masses of uredospores, the whole under-surface of the leaf. I have never found *Hemileia* on any part but the leaf.

The teleutospores are very rarely met with, and never on leaves which are still adherent to the trees.

A search has been made, but not as systematically as could be wished, for a possible *Æcidium* condition. Unfortunately, the element of chance entering into this research is great. When found the intermediate host may not be easily extirpated, and again, its destruction might not affect the prevalence of the uredo-stage of the fungus.

The following genera of the Rubiaceæ occur in the Victoria Nyanza Region: *Mitragyne*, *Oldenlandia*, *Mussænda*, *Dictyandra*, *Gardenia*, *Belonophora*, *Canthium*, *Vangueria*, *Craterispermum*, and *Pavetta*.

At least four of these genera have been found to harbour species of *Hemileia* in other parts.

On the whole, one is safe to conclude that the present outlook is favourable to coffee planters in Uganda, not only because of indications that the disease may be less virulent than formerly, but also, and especially, because planters are realizing that measures must be taken against *Hemileia*.

IL R. GIARDINO COLONIALE DI PALERMO E LA SUA ATTIVITA.

Per il Professore A. Borzi.

Direttore del R. Giardino Coloniale di Palermo.

L'istituzione di un R. Giardino Coloniale a Palermo, oltre che il riconoscimento del reale e sentito bisogno di un organo di tal genere nella nostra Patria, è stata un portato spontaneo delle particolari risorse naturali della Sicilia. Il detto Istituto non è che una derivazione dell'Orto Botanico universitario di Palermo. Questo, durante la sua più che secolare esistenza, si è distinto da tutti gli altri Istituti del genere d'Italia e d'Europa per la caratteristica ricchezza di coltivazioni tropicali a pien'aria, alle quali il favore del clima meridionale conferisce un rigoglio non dissimile da quello delle flore dei Tropici. Dalla considerazione di questo fatto, per il quale l'Orto Botanico è andato rinomato in Italia e fuori, all'idea di sfruttare tali eccellenti attitudini, nel senso di fare dell'Orto stesso non solamente un museo vivente di rarità vegetali, ma anche un centro destinato a diffondere fuori dei suoi stessi confini la conoscenza delle ricchezze vegetali esotiche per scopi pratici, non vi era che un passo. E, benchè non ne avesse esplicitamente la funzione, l'Orto Botanico, per cura dei suoi Direttori, assolse molte volte questo compito, introducendo nell'agro siciliano numerose colture nuove, alcune delle quali sono ora diffusissime e costituiscono dei cespiti non indifferenti dell'Agricoltura nostrana.[1]

Col graduale diffondersi, poi, anche in Italia degli studi sull'Agricoltura tropicale, in seguito allo stabilirsi di vasti interessi nazionali in regioni aperte alla colonizzazione ne parve più che mai evidente l'utilità di un centro che di

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[1] Tale è ad es. la coltura del manderino e del nespolo del Giappone in Sicilia.

tali studi fosse stato competente promotore. Quale migliore designazione, quindi, per la fondazione di un tale Istituto in Italia, come già ne esistevano all'Estero, se non la città di Palermo, dove già il clima, la tradizione, l'ambiente stesso, ne formavano la migliore, la più naturale base?

Cosi dunque è sorto a Palermo un Giardino specializzato allo studio delle coltivazioni coloniali, dapprima in veste modestissima, quale una semplice appendice dell'Orto Botanico universitario, oggi finalmente come Ente autonomo, sotto il nome di "R. Giardino Coloniale."

Storia.

Nel 1905, discutendosi alla Camera dei Deputati la legge del Bilancio della P. Istruzione, l'On. Casciani cosi si esprimeva parlando dell'Orto Botanico di Palermo: —

"Quando in Italia esisterà veramente un Ministero di Agricoltura, un Ministero cioè che intenda la sua missione, sospingendo gli studi sperimentali volti a favorire nuove colture che sono di tanto interesse per alcune regioni, sopratutto per le regioni del Mezzogiorno, ove alcune colture soffrono per eccesso di produzione, allora soltanto si potrà intendere quale vantaggio potrà portare al paese l'Orto Botanico di Palermo, che per la sua posizione, per la sua estensione, e per il modo col quale è diretto può portare un importante contributo alla soluzione di molti problemi riflettenti la nostra agricoltura."

In quella occasione la Camera votava un ordine del giorno nel quale si invitava il Governo a sollecitare la trasformazione dell'Orto Botanico di Palermo in Istituto Botanico internazionale, come era già stato deliberato in un altro precedente ordine del giorno.

Nel 1906, per iniziativa del Ministero degli Affari Esteri e col concorso dei Ministeri dell'Agricoltura e della P. Istruzione veniva istituita nell'Orto Botanico palermitano una "Sezione coloniale" destinata a studi di acclimazione di piante tropicali, con una piccola dotazione ed un personale proprio.

Nel 1910, per determinare meglio le funzioni e le attribuzioni del piccolo Istituto venne dato corso ad un progetto che ne contemplava altressi l'ampliamento e la sistemazione definitiva.

Nel Febbraio, 1913, il Ministero della P. Istruzione, di concerto con quello dell'Agricoltura, delle Colonie e del Tesoro, presentava al Parlamento Nazionale il disegno di Legge relativo, che nel Giugno successivo veniva approvato dalle due Camere e poscia pubblicato l'll Luglio sotto il No. 971. Un recente Decreto Reale ha approvato infine il Regolamento che dà esecuzione alla Legge stessa.

Per questa Legge il R. Giardino Coloniale di Palermo è eretto in Ente autonomo ed ha una dotazione fissa di L. 8,000 annue. Può valersi inoltre dei contributi di Enti pubblici e privati e dei proventi della propria gestione. Detta dotazione e le spese per il personale sono inscritte in un capitolo speciale del Bilancio della P. Istruzione.

Relazioni e manifestazioni ufficiali della "Sezione Coloniale."

Dalla sua fondazione ad oggi Sezione Coloniale dell'Orto Botanico di Palermo ha mantenuto rapporti continui e regolari con i principali Enti Coloniali del Mondo e specialmente con le Colonie italiane di dominio diretto.

Nel 1910 essa figurava degnamente alla Mostra orticola-Commerciale tenutasi a Palermo, esponendovi le sue meravigliose coltivazioni esotiche di pien'aria, ottenendo la medaglia d'oro del Re ed il compiacimento degli stessi Reali, venuti in quella occasione ad onorare della loro visita la Mostra.

All'Esposizione di Firenze del 1911 il Giardino otteneva parimenti una medaglia d'oro. Numerose altre onorificenze, di più antica data conta anche l'Orto Botanico per l'attività spiegata nello stesso campo.

Attività dell'Istituto nella Madre-patria.

Nei riguardi del miglioramento e della trasformazione delle colture della Madre-patria segnaliamo anzitutto l'opera spiegata in favore della Cotonicoltura. Insieme con gli studi tecnici è scientifici, l'Istituto ha cercato col mezzo di campi sperimentali e col sussidio di ogni agevolazione pratica possibile, di estendere questa coltura in Sicilia e nel Mezzogiorno d'Italia; numerosissimi campi sono stati istituiti e diretti dall'Istituto dalla sua fondazione ad oggi.

Pregevolissimi e di antica data, ma non ancora entrati nel campo della pratica attuazione per molteplici difficoltà economiche sono gli studi sui *Ficus* da gomma elastica. I prodotti in caoutchouc proveniente dal latice di tali piante coltivate nel Giardino di Palermo furono premiati con medaglia d'oro all'Esposizione di Milano del 1906.

Molte altre piante da gomma sono state studiate, e tra esse *l'Atractylis gummifera*, specie diffusissima in Sicilia che ora è oggetto di sfruttamento industriale da parte di alcune Società.

Pure molto diffusa, ed accolta ovunque favorevolmente è la coltivazione del *Sisal* in Sicilia ed in altre parti d'Italia.

Coltivazioni promosse e diffuse dal Giardino palermitano sono pure quelle di varie essenze forestali, quali quelle del *Myoporum serratum* in vari punti della Sicilia, della Calabria e della Libia, adoperato specialmente per rinsaldamento di terreni mobili; quelle dell'*Acacia horrida* sulle lave vesuviane e nell'agro messinese; quelle della *Chloris Gayana*, eccellente erba da foraggio estivo, nell'interno arido e montuoso della Sicilia; quelle del Banano, del Mango, della nocciola americana, della patata dolce, della pianta della razzia, ecc. in molti punti dell'Isola e del meridionale d'Italia.

Molte altre piante esotiche d'interesse economico sono allo studio od in corso di sperimentazione, quali le Palme da datteri come piante da frutto in Sicilia, il Thè, ecc. Altre piante proprie della flora siciliana o già da tempo acclimatate sono anch'esse oggetto di studio per un maggiore sfruttamento industriale dei loro prodotti o per trarne eventuali nuove risorse. Citiamo: il Fico d'India, la Palma da scope, il Girasole, ecc.

Attività svolta nelle Colonie.

Nei riguardi dell'Agricoltura propria delle Colonie italiane di dominio diretto, solo ora, coll'avvenuta estensione della sua importanza e delle sue risorse il Giardino ha potuto cominciare un'azione di qualche rilievo. Tralasciando di menzionare le varie forniture di piante eseguite in questi ultimi mesi per conto del Ministero delle Colonie e dei Governatori della Libia, ricorderemo che attualmente il Giardino, per mezzo di un suo impiegato, va provvedendo alle piantagioni ferroviarie lungo le linee della Tripolitania e della Cirenaica, per incarico dell'Amministrazione delle Ferrovie dello Stato.

Insegnamento.

Per ciò che riguarda l'insegnamento l'Istituto si è fin'ora ispirato soltanto ai bisogni delle masse emigranti agricole ed ha sostenuto la necessità di una istruzione agraria preventiva dei contadini emigranti sulle coltivazioni proprie dei paesi ai quali si dirigono. Ha istituito perciò tre anni or sono un Corso trimestrale di colture coloniali destinato a contadini, epperò di carattere essenzialmente pratico, riflettente le norme di una razionale coltivazione di piante esotiche affatto sconosciute all'agricoltura patria.

L'efficacia pratica di siffatto insegnamento, oltre che nella forma assolutamente elementare e semplice con cui è impartito il corso, va risposta principalmente nelle esercitazioni che i contadini stessi eseguono attorno alle coltivazioni trattate, esistenti in Giardino. Il corso non è quindi che un esperimento diretto di coltivazioni coloniali eseguito nella Madre-patria. Senza dubbio molti miglioramenti potrà avere ancora quest'opera, qualora non manchi sopratutto il benevole incoraggiamento dello Stato ed il concorso degli Enti. Tra i frequentatori del Corso si sono avuti numerosi soldati contadini del presidio di Palermo, i quali vi partecipavano con permesso speciale del Ministero della Guerra.

Materiali da studio: Museo, Biblioteca, Laboratori, ecc.

Come annesso dell'Orto Botanico palermitano il Giardino Coloniale si è valso e si vale tutt'ora del materiale scientifico di quest'ultimo, che non lascia alcunchè e desiderare.

Il Museo Coloniale, di cui fanno parte anche le antiche collezioni dell'Orto Botanico, comprende oramai un numero grandissimo di prodotti, provenienti dalle Colonie italiane e da altri paesi tropicali. Citiamo le collezioni di legnami dell'Eritrea, quelle di prodotti e manufatti di fibre tessili, quelle di frutti e semi eduli. Figurona anche molto degnamente prodotti di piante coloniali provenienti dalle colture dello stesso Giardino.

La Biblioteca comprende oltre 10,000 opere ed opuscoli e circa 200 periodici botanici ed agrario-coloniali.

L'Erbario coloniale è ricco fin'ora di circa 5,000 specie, raccolte direttamente nei luoghi d'origine da vari corrispondenti.

I Laboratori, nei nuovi locali dell'Istituto Botanico universitario di Palermo, comprendono sale per ricerche micrografiche, per esperienze di fisiologia e patologia vegetale e ricerche di chimica agraria, fornite di ogni sorta di strumenti, apparecchi, ecc. di recentissimo acquisto e di grande valore.

Giardino.

L'area propriamente destinata alle colture del Giardino Coloniale ammonta a circa 4 Ea. Altri terreni fuori dei suoi stessi confini sono stati frequentemente presi in affitto ed adibiti ad uso di sperimentazione. Piante ed associazioni floristiche tipicamente coloniali si trovano però anche in terreno dell'Orto Botanico, ivi da lunghi anni coltivate. Una superficie speciale è riservata alle prove di concimazione delle varietà di cotone; altre servono per piante annue od erbacee perenni fecolifere, oleifere, alimentari, tintorie. Altre ancora sono adibite a vivai per *Agave sisalana*, *Chloris Gayana*, ecc. Sono notevoli i boschetti di *Ficus elastica*, di Banani, di Palme da Datteri, i gruppi di liane tropicali, i bacini di piante acquatiche, le collezioni di piante grasse, ecc.

Coltivazioni coloniali.

Il numero delle specie di piante coloniali perenni od annuali, coltivate a pien'aria o eventualmente dentro stufe, supera le 2,000. Circa 220 sono piante da legnami, notevoli fra le quali le specie di *Diospyros* che forniscono l'ebano, l'*Agathis australis* (legno di Kauri), l'*Anacardium occidentale* (legno di acajou), la *Bumelia tenax* (legno di ferro), la *Jacaranda mimosaefolia* (legno di palissandro), ecc. Le piante tessili o papirifere sono rappresentate da

120 specie, fra cui l'*Agave americana* (fibre di zabara), l'*Agave sisalana* (fibre di sisal), la *Calotropis procera* (seta vegetale), la *Cannabis sativa* (canapa), la *Carludovica palmata* (paglia di panama), il *Corchorus olitorius* (juta), l'*Eriodendron anfractuosum* (Kapok), il *Phormium tenax* (lino della Nuova Zelanda), ecc. Circa 50 sono le specie che forniscono tannino, fra le quali la *Caesalpinia coriaria* (divi-divi), l'*Eucalyptus diversicolor* (karri), la *Quercus aegylops* (vallonea), la *Rhus coriaria* (sommacco) e le varie specie di *Acacia*. Più di 40 specie sono piante tintorali, tra cui citiamo lo Zafferano, l'indaco (*Indigofera tinctoria*), lo *Gnado* (*Isatis tinctoria*). Circa 75 specie spettano alle piante a gomme o resine, tra le quali le *Acacie* a gomma arabica, la gomma di Kuri (*Agathis australis*), la gomma di Drago (*Dracaena Draco*), la gomma d'Euforbio (*Euphorbia antiquorum*), ecc.

Le piante a caoutchouc sono rappresentate da 24 specie; notevoli fra esse, oltre al *Ficus elastica*, l'*Hevea brasiliensis* che fornisce il Caoutchouc di Parà, il *Manihot Glaziovi* (Caoutchouc di Ceará), il *Parthenium argentatum* o Caoutchouc di Guayule, ecc. Oltre 70 le specie ad essenze di cui alcune importantissime nell'industria dei profumi, ed 80 circa le piante oleifere. Le piante medicinali sono rappresentate da quasi 150 specie alcune delle quali rarissime; ed altre 75 sono specie a frutti e semi eduli o che forniscono fecola o zucchero, come le specie di *Dioscorca*, la *Mangifera indica*, varie specie di *Anona*, la *Persea gratissima*, la pianta del Cacao, ecc.

DELL'USO DELL'ACIDO CLORIDRICO, O DI ALTRE SOSTANZE ACIDE MINERALI, E DI SOSTANZE SPECIALI, PER LA CONSERVAZIONE E BUONA MATURAZIONE DEI FORAGGI IN SILO, NEI CLIMI CALDI.

Per il Professore Italo Giglioli.

Della R. Università di Pisa.

L'uso di conservare i foraggi verdi nel Silo è, nei climi temperati e piovosi, una pratica utile, ma non sempre di grande necessità. Invero, vi è ancora chi dissenté sulla utilità ed il vantaggio economico dell'insilamento nell'agricoltura dei paesi più temperati di Europa. Per i foraggi di migliore qualità, molti preferiscono la fienagione all'insilamento; benchè sia stato in parecchie prove comparative dimostrato, in particolare negli Stati Uniti, che il conservare il foraggio sotto forma di insilato costi meno che conservarlo come fieno [1].

Nei climi più aridi, dove il disseccamento avviene rapidamente, l'aroma ed altre importanti qualità del fieno vengono a scapitare; e questa è probabilmente la ragione del minore valore nutriente e commerciale del fieno degli Stati Uniti, in paragone col fieno delle più temperate parti di Europa, dove il fieno arriva nei fienili non soverchiamente secco ed in condizioni da subire quelle lente alterazioni, le quali sono analoghe alle alterazioni caratteristiche del buon insilato. Così durante pochi mesi il fieno posto in fienile può subire dei cali anche del 10 per cento [2].

Nei climi umidi il bestiame può facilmente ricevere foraggio verde e succolento, sia sotto forma di erba, sia sotto forma di radici, durante tutte le stagioni dell'anno.

D'altra parte, anche nei climi umidi e freschi, si possono avere condizioni che consigliano la conservazione dei foraggi allo stato verde e fermentato, sia perchè la stagione può non essere sempre favorevole ad una buona fienagione, sia perchè per certe produzioni agrarie, come quella del latte, la provvista di foraggio succolento non è mai troppa. Così vediamo che l'uso dell'insilamento fatto in Silo a fossa, od in Silo sopra terra, ed anche in Silo a semplice mucchio compresso, si è andato sempre più estendendo, specialmente nei paesi più aperti al progresso agrario. Negli Stati Uniti, dove l'allevamento del bestiame acquista sempre maggiore importanza, l'uso dei Silo per foraggio verde, specialmente di Mais, si è grandemente esteso in questi ultimi anni; recentemente si calcolava che in alcuni stati della Unione americana si avesse almeno un Silo per ogni cinque poderi.

Vi sono poi alcune sostanze, residui delle industrie agrarie, come le polpe di barbabietola e di distillerie, le quali sono troppo acquose per poter essere convenientemente essiccate; essendo alterabilissime, è giocoforza conservarle coll'infossamento. In Germania, in Francia, in Austria-Ungheria, ed in Italia, sono migliaia e migliaia di tonnellate di queste polpe acquose che bisogna ogni anno infossare appena uscite dai zuccherifici. A cagione di pratiche non bene intese queste polpe, tanto facili a guastarsi, non sempre si possono bene conservare, in modo da apparecchiare pel bestiame un foraggio sano e nutriente.

Ma è nei climi aridi e caldi dove l'uso d'infossare il foraggio verde, e prepararlo per il consumo durante la stagione secca, sarebbe pratica più che mai necessaria, per assicurare all'agricoltura quelle basi sicure di sviluppo, le quali consistono principalemente nel buon allevamento del bestiame.

In questi climi asciutti, le pioggie possone essere sufficienti ad assicurare nella primavera unà precoce ed abbondante produzione verde; ma poi subentra la lunga stagione estiva nella quale, anche quando vi fosse, come raremente avviene, buona provvista di fieno e di mangime secco, il bestiame deperisce per difetto di foraggi freschi e succolenti.

A questo difetto si può sopperire soltanto per mezzo dello insilamento dei foraggi verdi, a primavera. Si comprende come in alcuni climi aridi, per esempio nell'Australia, l'uso dei Silo si vada estendendo vieppiù. Nel Victoria erano 160 i poderi nel 1906 provvisti di Silo; ma dopo quattro anni, nel 1910, il numero di questi poderi era salito a 590; e la quantità di foraggio insilato da 7,240 tonn. era salita a 27,000 tonn. [3].

Si aggiunga che nei climi caldi la vegetazione spontanea e quella arborea possono offrire materiale di scarto che mal si presterebbe al disseccamento, inquantochè richiede un processo di fermentazione (od enzimica o bacterica) per diventare gradito al bestiame e meglio adatto alla sua alimentazione.

Vi sono climi aridi, come avviene in Libia, nei quali la scarsissima produzione di piante foraggiere non basta al sumo immediato. Ivi non è in uso neppure la fienagione, e tanto meno lo potrebbe essere, nelle condizioni attuali, l'insilamento. Ma anche in queste condizioni estreme, l'utilizzamento della vegetazione spontanea e del fogliame di alberi che si possono adattare a vivere su terreni molto poveri, sarebbe pratica di evidente utilità. La Tunisia ci offre buoni esempi dell'utilizzamento di piante spontanee di poco valore mediante l'infossamento allo stato verde.

Ma se nei climi temperati non è sempre facile conservare il foraggio verde e fermentato senza che subisca perdite sensibili, e senza che vi sia il rischio che una buona parte dell'insilato si guasti al momento del consumo, la difficoltà ed i rischi sono molto maggiori quando il clima è caldo; e quando il Silo deve incominciare ad apririsi nella stagione quando più alta è la temperatura e quando più rapide di conseguenza sono le alterazione putrefattive.

Durante la conservazione nel Silo, è inevitabile la perdita di una porzione della materia secca, dovuta alle fermentazioni varie ed ai processi di respirazione cellulare. Quando l'infossamento viene fatto a buona regola d'arte, preparando insilato acido anzichè insilato dolce, escludendo nel modo più accurato possibile l'aria dal Silo, e riducendo al minimo le superficie che sono più esposte all'azione esterna, la perdita di sostanza secca si può grandemente attenuare. A Rothamsted, nell'Inghilterra, dove per molti anni l'argomento venne accuratamente studiato, la conclusione generale è stata che coll'insilamento si può preparare un buon foraggio, con una perdita di sostanza secca non molto differente da quella che si verifica nella fienagione. Angelo Menozzi e Vittorio Alpe a Milano, in esperimenti fatti nel 1891, con trifoglio infossato in Silo in muratura, dopo una conservazione rispettivamente di 4, 10 e 8 mesi, trovavarono che le perdite in sostanza secca erano del 12·1, del 14·5 e del 13·3 per cento; tale perdita era del 15·87 per cento nel caso di erba da prato, conservato a mucchio, colla pressa Blunt. In questa pressa, come in tutti i Silo a mucchio, per quanta cura si possa avere nell'accrescere la pressione quando nell'interno vi è segno di crescente temperatura, le perdite sono quasi sempre rilevanti, essendo le pareti del mucchio esposte all'azione dell'aria, e quindi alla invasione delle muffe; le quali, decomponendo gli acidi organici del foraggio insilato, lo predispongono a rapida putrefazione [4].

Ma anche nel caso di foraggi infossati dentro a Silo a fossa, od altrimenti ben chiusi, le perdite possono essere notevoli. Nelle accurate esperienze di H. E. Annett ed E. J. Russell, a Wye, nel 1904 e 1905, essi trovarono una perdita di sostanza secca nel Mais insilato uguale al 36 per cento. Questi autori disponevano alcuni sacchetti, pieni del foraggio fresco, bene chiusi con cucitura, e pesati, in vari punti della massa di foraggio di Mais verde, all'inizio dell'insilamento; e dalle variazioni di peso totale e della composizione chimica, calcolavano la perdita in sostanza secca e nei vari costituenti. Queste perdite di sostanza secca sono dovute principalmente allo svolgimento gasoso, che si verifica nei processi fermentativi, che hanno luogo durante l'insilamento, specialmente nei primi giorni. Ma oltre a queste perdite gasose, che coi metodi in uso nell'insilare, si debbono considerare inevitabili (e sono, secondo la espressione di F. H. King, come la "respirazione dell'insilato"), le forti perdite determinate da Annett e Russell sono dovute in parte anche a trasudamenti, che dai singoli sacchetti di tela dovevano aver luogo verso l'insieme della massa insilata. Si può comprendere, dunque, come le perdite di sostanza secca, determinate col metodo dei sacchetti, possano segnare cifre superiori a quella di tutta intiera la massa di foraggio fermentato nel Silo, quando questo sia bene costruito e chiuso. Il calo di sostanza secca, determinata dai due recenti sperimentatori inglesi, è infatti superiore a molte altre determinazioni, come quella citata del Menozzi, e come in parecchie delle osservazioni fatte da sperimentatori negli Stati Uniti, in Italia e in Germania [5].

Kühn e Menzel, come ricorda F. H. Storer, verificavano nel Mais insilato una perdita di sostanza secca di circa 23·4 per cento. O. Kellner ammette che nell'insilamento le inevitabili perdite debbono variare fra 20 e 35 per cento della sostanza secca. D'altra parte, negli Stati Uniti, con Mais insilato, Armsby e Caldwell ebbero una perdita di sostanza secca del 17·78 per cento; la quale paragonava bene colla perdita del 20·34 per cento nella materia secca dello stesso Mais affienato sul campo. C. D. Smith, nel Michigan (1902), trovava che le perdite variavano dal 14·5 al 20·3 per cento, nel peso totale durante l'insilamento. Sono perdite che nella pratica possono subire delle variazioni notevoli, variazioni che S. M. Babcock ed H. S. Russell ammettono possano oscillare fra 3 per cento e 40 per cento a cagione del vario modo nel quale nella pratica si raggiunge lo scopo di tener fuori l'aria dal Silo durante tutto il non breve periodo della sua chiusura.

D. Feruglio ed L. Mayer, sperimentando ad Udine nel 1910, trovarono che nell'infossamento del Mais, la perdita di sostanza secca non oltrepassava la cifra del 10 per cento [6].

Come vedesi, abbiamo variazioni grandissime nella valutazione della perdita di sostanza secca. Anche nelle esperienze in piccolo, dentro bottiglioni, E. J. Russell trova il 25 per cento di sostanza secca perduta dal Mais verde insilato. Basta l'accesso dell'aria per far salire le perdite al 60 per cento.

La natura del foraggio che viene insilato dovrà molto influire sulla facilità colla quale perde sostanza secca durante l'insilamento. I foraggi che meglio si conservano sono quelli più zuccherini, come il Mais, i Sorghi, la Saggina ecc. nei quali, durante i primissimi stadi dell'insilamento, lo zucchero si viene mutando ad acidi, quali l'acetico ed il lattico, in modo che la massa arriva ad acquisare una certa acidità che si approssima all'1 per cento. Questo grado di acidità impedisce l'attività dei fermenti anaerobici, ed arresta ogni ulteriore alterazione della massa insilata, almeno fino all'apertura del Silo, purchè coll'andare del tempo l'acidità non sia gradatamente eliminata dalla ammoniaca che si viene producendo nel disgregarsi proteolitico delle sostanza proteiche. Questa disgregazione proteolitica (la quale sembra del tutto indipendente dalla azione microbica) dalla quale si generano ammine ed ammoniaca, costituisce il punto incerto sulla efficacia del metodo che in questo scritto si propone [7].

Nei foraggi verdi, nei quali vi è difetto di zucchero e relativa prevalenza di proteici, come avviene nel caso della medica, del trifoglio, della veccia e di altre leguminose, o nel fogliame di bietole, di cavoli o di alberi (a più ancora nelle polpe esaurite di zuccherificio e di distilleria) il foraggio non può acquistare rapidamente la necessaria acidità durante i primi giorni di insilamento. In questi casi, nei quali difetta l'azione protettiva dell'acido lattico e di altri acidi organici, ed è forse maggiore l'ammoniaca prodotta, le alterazioni fermentative si accentuano ed il consumo di materia organica secca si fa rilevante; e diventerà rilevantissima se si fa un semplice interramento in fosse, senza muratura, o se il Silo non è a buona tenuta di aria.

F. Tangl ed S. Weiser, nel 1910, in Ungheria, facendo Silo a semplice interramento in fosse, ebbero colla Erba Medica diminuzioni notevoli di sostanza secca e di valore alimentare, perdite, invero, dovute anche in parte ad infiltramento. Nello infossamento di foglie e colletti di barbabietola la perdita di materia secca arrivò anche al 54·9 per cento. Si comprende come con tali risultati, dovuti principalmente al modo di insilare, e forse anche alla temperatura alta della estate in Ungheria, li sperimentatori Ungheresi non si dimostrino molto persuasi della utilità pratica dell'insilamento [8].

Oltre alla natura del foraggio verde che si insila, le condizioni di clima dovranno molto influire sopra le perdite di sostanza secca e di valore alimentare che avvengono nei Silo. Nei climi caldi, seguendo i metodi consueti, le oscillazioni nella buona riuscita dell'insilamento e nel valore del foraggio conservato dovranno essere molto maggiori che nei climi temperati. Nella inchiesta fatta do J. A. Voelcker nel 1893, sui risultati nella pratica dell'insilamento nell'India, egli veniva a conclusioni poco confortanti, temendo che tale pratica non potesse utilimente molto estendarsi, ma limitarsi solo a quei foraggi che non si potrebbero altrimenti utilizzare. Nel caso di insilamenti con Panicum jumentorum (Guinea Grass) e di Sorghum vulgare (Jouar) le perdite ammontavano rispettivamente al 49 per cento ed al 33 per cento del peso del foraggio fresco. Tali perdite derivavano in parte dall'essiccamento ed in parte da poca cura nel comprimere l'insilato, lasciandolo poi troppo esposto all'azione dell'aria durante il consumo [9].

La vecchia regola di Goffart, che nel comprimere un foraggio insilato conviene limitare la pressione, in modo da non spremere il succo, obbligando questo al accumularsi nel fonda del Silo, è regola che in particolar modo va osservata nei paesi aridi e caldi. Ivi conviene anzitutto, che la intera massa dell'insilato conservi la naturale succolenza. Il liquame organico, che si accumula nel fondo del Silo, diventa presto, quando il Silo viene aperto e l'aria introdotta, un fomite di processi putrefattivi, facili a contaminare tutta la massa del foraggio. Nei climi caldi, anche quando il Silo è ben costruito, è durante il consumo del foraggio, allo schiudersi del Silo, che si accelera il guastarsi ed il perdersi di una forte proporzione di foraggio.

Pressioni moderate nei Silo, siano essi a fossa od a torre od a mucchio, saranno possibili soltanto dove il foraggio stesso, fino dall'inizio dell'insilamento, è stato reso poco alterabile, mentre che l'acquosità della massa è accresciuta e bene ripartita e conservata; e l'aria interstiziale fino dalla chiusura del Silo è mantenuta del tutto disossigenata. Si miri a rendere il foraggio dentro il Silo, e dal primo momento della sua uscita dal Silo, inconsumabile dai fermenti e bacteri, e possibilmente poco alterabile dagli enzimi, anzichè limitarsi (come vien fatto nella pratica usuale) a proteggere il foraggio dall'accesso dell'aria, fidando soltanto nell'azione protettrice dell'inacidimento spontaneo, enzimico e bacterico. Quelle stesse azioni chimiche che proteggono la sostanza insilata dalle alterazioni contribuiscono ad accrescerne ed a bene ripartirne la succulenza.

Oltre al metodo noto, ma poco usato, del trattamento con sale pastorizio (che non sembra esercitare nel Silo una particolare azione protettiva), vari metodi sono stati tentati, o che si potrebbero meglio tentare, per rendere poco e lentamente alterabile la massa insilata; essi si possono ripartire sotto i seguenti capi:—

(1) Scottatura della massa insilata con vapore.

(2) Inoculazione con fermenti lattici.

(3) Aggiunta di melasse, o zucchero.

(4) Trattamento con antisettici speciali, come Solfuro di carbonio.

(5) Trattamento con acidi specialmente minerali, o con sostanze minerali acide.

Trattamento con vapore.—Questo metodo è stato applicato da A. L. Knisely, della Stazione Agraria dell'Oregon. Le prove si fecero in Silo piccoli e grandi, l'insilato scottato con vapore conservandosi meglio di quello ordinario. L'insilato cotto venne fornito ai bovini in razioni quotidiane di 50 a 75 libbre inglesi. Le prove fatte nel 1905 mostravano che il Mais verde sarebbe il foraggio più adatto per la iniziale cottura al vapore; la quale tende a mantenere bassa l'acidità della massa insilata. Infatti, nelle prove di confronto, il mais insilato ordinario aveva una acidità media di 1·58 per cento, mentre nell'insilato cotto l'acidità media era di 0·53 per cento soltanto. Questa bassa acidità dovrebbe rendere l'insilato cotto molto proclive a guastarsi quando il Silo viene aperto, specialmente in un clima caldo. La cottura o piuttosto una parziale scottatura al vapore, non può arrivare a distruggere completamente i micro-organismi. Nell'insilato vi sono bacteri termo-resistenti sporigeni, i quali resisterebbero anche ad una vera e propria cottura; nel caso poi di una scottatura, necessariamente imperfetta e non uniforme, la sopravvivenza bacterica non dovrebbe essere lieve. È certo però che coll'arrestare le alterazioni dovute al protoplasma vivente nelle cellule del mais, e quelle dovute ad enzimi, e nel ridurre grandemente l'attività bacterica, la cottura deve ridurre le cause di perdita di sostanza organica e di deterioramente nutritivo nella massa insilata. Nelle esperienze in piccolo di E. J. Russell, il mais insilato normale subì una perdita di materia secca del 25 per cento; invece, il mais riscaldato a 98 per cento rimase inalterato e con una perdita del 12 per cento soltanto.

Nella grande pratica, l'uso della cottura del foraggio insilato dovrà certamente riuscire costono e non sempre di facile applicazione [10].

Dalle prime classiche ricerche di G. Lechartier, nel 1881 fino a quelle recenti di S. M. Babcock e H. L. Russell negli Stati Uniti, e di E. J. Russell in Inghilterra, ci conferma sempre più la opinione che l'azione dei bacteri nella formazione dell'insilato è un'azione secondaria.

La trasformazioni nel Silo sarebbero dovute principalmante al protoplasma delle cellule viventi del foraggio verde ed agli enzimi che questo protoplasma secerne, e che anche dopo la sua morte ne continuano l'azione. Anche sotto la influenza di antisettici, come cloroformio, etere, e toluene, che arrestano la attività bacterica e quella del protoplasma, ma rispettano l'attività enzimica, il foraggio verde chiuso nel Silo prosegue nelle principali sue caratteristiche trasformazioni [11].

I bacteri sono consumatori molto attivi di non piccola parte della sostanza organica del foraggio insilato. Perciò considerando che l'azione trasformatrice dei microbi nel Silo è più dannosa che utile, sarebbe desiderabile, quando fosse possibile, eliminare completamente nell'insilato l'azione di ogni sorta di microbi. D'altra parte, i bacteri aiutano nella produzione dell'acidità complessiva del foraggio insilato; e questa acidità, tanto più utile quanto più fissa, come quando è dóvuta all'acido lattico, esercita un'azione protettiva contro i bacteri anaerobici più nocivi, e contro i bacteri tutti, che in particolare tendono rapidamente a svilupparsi prima del completo riempimento del Silo ed al momento della sua apertura. Perciò malgrado la loro azione consummatrice sugli zuccheri e sopra altri carboidrati solubili, o solubilizzabili, del foraggio insilato, si cerca di aiutare nel Silo lo sviluppo ed il predominio dei fermenti lattici. Indi l'uso di culture selezionate di questi fermenti lattici, da aggiungere al foraggio verde, quando prima viene stratificato nei Silo, e la cura nel mantenere nei Silo le condizioni più favorevoli allo svolgersi della fermentazione lattica.

La pronta chiusura del Silo, uniforme e completa stratificazione e compressione del foraggio ben trinciato e la completa esclusione dell'aria esterna, oltre all'impedire che sin dallo inizio la temperatura della massa insilata oltrepassi i limiti di 30° a 35° C. son condizioni tutte che meglio assicurano il buon sviluppo dei fermenti lattici e la loro azione protettiva. Tale azione protettiva deriva essenzialmente dal grado di acidità che i bacteri lattici danno (o dovrebbero dare) a tutta la massa insilata: l'acidità si aggira intorno all'1 per cento circa, non potendo oltrepassare certi limiti, oltre i quali l'acido lattico stesso reprimerebbe lo sviluppo dei fermenti che lo generano [12].

Gli studi di Stanislao Epstein, nel 1902, per la buona conservazione nei Silo delle polpe di barbabietola, prima dimostrarono la utilità di accrescere artificialmente nell'insilato le culture dei fermenti lattici. Le polpe di zucherificio sono molto adatte per questa applicazione. Tali polpe, quando escono dai diffusori, sono, a dovrebbero essere, quasi sterilizzate, salvo la resistenza di spore e di germi termo-resistenti e termofili; perciò queste polpe sono in condizioni favorevoli per rapidamente giovarsi della inoculazione con una coltura bacterica selezionata. Questa, risvegliando la fermentazione lattica, impedisce il nascere dei germi nocivi nelle polpe; le quali, a cagione della loro grande acquosità, sono alterabilissime quando vengono insilate. Si aggiunga che nelle polpe di zuccherificio, rimaste esposte alle forti temperature dei diffusori, il protoplasma delle cellule vegetali è stato ucciso, e gli enzimi sono stati decomposti; perciò è solo col promuovere i bacteri lattici che si assicura nell'insilato l'azione protettiva dell'acido lattico.

In Francia si trova in commercio, fino del 1909 un prodotto che va sotto il nome di Lacto-pulpe, patentato dai Signori Bouilliant e Crolbois, che serve per la inoculazione delle polpe di barbabietola e di altri foraggi da insilare. Nella Scuola Agraria di Berthonval, in Francia, i Signori Malpeaux e Lefort fecero, dal 1909 in su, svariate prove soddisfacenti con Lacto-pulpe, adoperandolo anche nel caso dell'infossamento di foraggi verdi. Questo Lacto-pulpe richiede un lavoro piuttosto complesso di attivazione culturale, prima che si possa applicare alle polpe ed ai foraggi posti in Silo. Il Gorini, che ha sperimentato in Italia questo prodotto francese, non se ne mestra troppo soddisfatto.

Negli Stati Uniti, nel Connecticut, W. Esten adoperava culture pure di bacteri acidificanti per accelerare la fermentazione iniziale del mais insilato, trovando che se ne migliorava la qualità. In Austria un prodotto simile è preparato per la inoculazione dell'insilato; esso va sotto il nome di Vindobona-Pulpe [13].

Gli esperimenti del Gorini hanno il merito di avere dimostrato la utilità dell'aspersione del foraggio di mais verde, al momento della sua stratificazione nel Silo, con una cultura selezionata di fermenti lattici. E probabile che nel caso dell'insilamento dell'erba medica, o trifoglio, od altre leguminose, nelle quali vi è difetto di zucchero e predominio di proteici, oltre all'aggiunta dei fermenti lattici, converrà ancora un trattamento con melasse, che assicurino col loro zucchero il buon successo dell'acidificazione lattica.

Nel climi caldi l'uso ed il trasporto lontano di culture bacteriche selezionate non deve nella pratica essere cosa molto sicura; si tratta di sostanze facilmente alterabili e non sempre capaci di una regolare attivazione culturale. Nei clima caldi le lotte fra le varie specie di microbi, pur tanto complesse e variabili quando le temperature sono basse, si svolgono attraverso troppo incognite, quando si tratta di una massa così complessa ed eterogenea quale è un foraggio insilato, dove varie ed opposte possono essere, nelle varie parti della massa, le fermentazioni predominanti. Sembra più ragionevole, volendo assicurarsi l'azione protettrice degli acidi, aggiungere direttamente le sostanze acide, nella loro forma più inalterabile ed effettiva, quale è quella degli acidi minerali, anzichè attendere che attraverso le loro lotte complesse i bacteri generino un acido facile esso stesso a sottostare a processi fermentativi.

Aggiunta di zucchero.—Questo trattamento non è ancora entrato nella pratica sperimentale, eccettochè in un tentativo del Dott. Samarani della Stazione di Caseificio di Lodi. Nelle sue ricerche, come nel metodo dei fermenti lattici selezionati, il Samarani mira a favorire nell'insilato la fermentazione bacterica a danno della fermentazione butirrica, partendo dal concetto (come si esprime D. Feruglio) che anche in seno alla pasta dei formaggi, la fermentazione lattica salva la caseina dalle fermentazioni butirrica e putrida.

"Per meglio riuscire nell'intento, il Samarani aggiunge al foraggio da infossarsi, assieme ai fermenti lattici, anche lo zucchero fermentescibile, elemento elettivo per la suddetta fermentazione, a mezzo delle melasse residuali della fabbricazione dello zucchero. I risultati sarebbero buoni. Mancano però anche qui finora le conclusioni definitive per l'applicazione del metodo nella grande pratica" [14].

Come sopra ho osservato, l'aggiunta dello zucchero, sotto forma di melassa, dovrebbe essere necessario, a complemento dell'inoculazione con fermenti lattici, nel caso che si vogliano insilare foraggi di leguminose. Anche Löhnis accenna alla utilità di arricchire con zucchero questi foraggi abbondanti in proteici, ma invece di melasse consiglia di far mescolanze con mais verde, od avena verde, od altri foraggi zuccherini [15].

Secondo il mio concetto, però, l'uso della melassa nell'insilamento dei foraggi, specialmente nei paesi caldi, potrebbe avere uno scopo più direttamente e propriamente antisettico di quanto queste melasse verrebbero ad avere quando usate semplicemente in sussidio alla fermentazione lattica. Lo zucchero, come è noto, quando è usato in certe proporzioni, agisce per conto proprio come sostanza antisettica, come vediamo nel caso del miele e delle melasse stesse, che si possono facilmente conservare a lungo. Se però, nel caso della conservazione dei foraggi verdi, si dovesse far uso soltanto di melassa come sostanza antisettica, le dosi dovrebbero essere troppo forti e costose, a meno che non si mirasse ad ottenere l'azione protettiva dell'acido lattico, mercè l'aggiunzione di una piccola percentuale sola di melassa. Quando invece la melassa, in proporzioni relativamente forti, tali da accrescere in modo evidente il valore alimentare del foraggio, si aggiungesse assieme con dell'acido cloridrico, nelle proporzioni corrispondenti all'acidità alla quale arriva un buon insilato acido, per esempio del 2 per cento, lo zucchero dovrebbe mantenersi inalterato ed aggiungerebbe la propria azione a quella dell'acido cloridrico per contrastare alle alterazioni che fanno diminuire sempre nell'insilato il primitivo valore alimentare del foraggio. Nella torba melassata, che si adopera come mangime, si aggiungono 80 parti di melassa a 20 parti di polvere di torba: questa ultima servendo a correggere l'azione alquanto lassativa che le melasse esercitano sul bestiame quando adoperate da sole. Nel caso dei foraggi insilati, le proporzioni potrebbero essere invertite. Bastano, proporzioni relativamente basse di zucchero quando questo viene applicato. Non conviene nei Silo sciupare melassa per fare acido lattico, il quale non ha valore alimentare; ma piuttosto con l'uso di piccole quantità di acido cloridrico, serbare intatto il duplice valore alimentare della melassa e del foraggio.

Trattamento con antisettici speciali, specialmente col solfuro di carbonio.—È noto che da molto tempo, dal 1887 il Dott. A. Grete, in Svizzera, proponeva l'uso del solfuro di carbonio per la conservazione del foraggio nei Silo. Gli esperimenti furono fatti su larga scala a Dissenhofen, nel 1887, adoperando 2 cmc. di solfuro di carbonio per ogni 2 litri di capacità del Silo. Il foraggio insilato fu trifoglio, il quale si conservò molto bene per sei mesi, avendo evidentemente subito alterazioni enzimiche (come si verificava nelle recenti esperienze americane ed inglesi con il cloroformio e col toluene), la cellulosa anche essa essendo stata in parte resa solubile. Il bestiame consumò avidamente il foraggio conservato con il solfuro di carbonio, senza soffrirne inconvenienti. Altre esperienze col metodo Grete furono fatte in Francia, nella Haute Garonne, nel 1893, dal Signor De Gineste, insilando trifoglio incarnato. Invece di irrigare con solfuro di carbonio, ed andare incontro a perdite ed altri inconvenienti, il De Gineste adoperava le capsule Jemain, il solfuro di carbonio essendo usato nella proporzione di Kgr. 2·3 per ogni mille Kgr. di foraggio. I resultati furono soddisfacenti, il trifoglio insilato conservandosi bene per due mesi.

In Svezia, come ricorda F. Storer, Alex. Mueller aveva adoperato solfuro di carbonio per mantenere inalterato un mucchio molto eterogeneo di residui vegetali, i quali vennero poi utilizzati vantaggiosamente come mangime.

Più recentemente, nel 1901, in Russia, J. Kalugin e S. Paraschchuck sperimentarono l'uso del solfuro di carbonio nell'infossamento del trifoglio pratense, del cavolo e delle carote da foraggio, paragonando anche gli effetti sul foraggio ben compresso, e poco compresso. In ambedue i casi il solfuro di carbonio contribuì grandemente alla buona conservazione dei foraggi, specialmente quando questi erano poco compressi. Si manteneva nell'insilato la struttura primitiva, mentre grandemente si riduceva la perdita di sostanza organica nutritiva. Dopo eliminati i vapori di solfuro, il foraggio restava con un odore piacevole, come di miele. L'effetto del solfuro di carbonio, come già aveva osservato Grete, è di arrestare in modo notevole nell'insilato lo sviluppo di acidi organici liberi [16].

Nei climi caldi l'uso del solfuro di carbonio, oppure anche del tetracloruro di carbonio, si dovrebbe certamente sperimentare per la conservazione dei foraggi. B. Görner, nel 1891, ricordava come il solfuro di carbonio si fosse dimostrato molto utile per la conservazione di polpe acquose di distillerie in climi tropicali, adoperando da 1 a 2 grammi di solfuro per ogni 1,000 litri di liquame [17].

Il solfuro di carbonio è un potente disinfettante, tanto come gas che in soluzione nell'acqua. Come, nel 1884, dimostrava Ckiandi Bey, il solfuro si scioglie nell'acqua nella proporzione di Gr. 0·50 per litro; e questa soluzione arresta tutti i processi fermentativi e microbici.

Non va però dimenticato che nel caso di foraggi contenenti sostanze cianogenetiche, come sarebberole diverse varietà di Sorghum, i vapori di solfuro, o di tetracloruro, eccitando le azioni enzimiche, potrebbero indurre la liberazione di acido cianidrico ed originare azioni tossiche. È un argomento che va ancora trattato sperimentalmente.

Trattamento dell'insilato coll'anidride solforosa.—Il Grete, nelle sue esperienze dal 1885 al 1887, fece anche una prova coll'anidride solforosa, osservando che in presenza di questo gas l'insilato svolge una quantità minore di gas che nel caso dell'insilato normale. In questo rispetto il solfuro di carbonio avrebbe agito ancora più energicamente che l'anidride solforosa. Nè il Grete, nè altri, per quanto io abbia potuto verificare, hanno ripetuto le prove sull'uso dell'anidride solforosa nell'insilamento.

Sarebbe certo opportuno che nei climi caldi si ripetessero queste prove sull'azione dell'anidride solforosa sui foraggi chiusi in Silo. Questo gas dovrebbe esercitare una triplice azione. Anzitutto, coll'intralciare tutti i processi di ossidazione, verrebbe ad assicurare rapidemente una di quelle condizioni che più son necessarie e sulle quali più s'insiste nella pratica dei Silo, e che si realizzano colla esclusione dell'aria. L' anidride solforosa, com' è noto, è in sè un disinfettante, che arresta tutte le azioni bacteriche e lo sviluppo di muffe, uccide il protoplasma delle cellule vegetali, impedisce l'azione delle ossidasie e probabilmente attenua tutte l'azione enzimiche. Infine, colla sua ossidazione, che potrebbe esercitarsi soltanto sopra una piccola parte del gas, l'anidride solforosa genera acido solforico; il quale colla sua acidità manterrà inalterato il foraggio quando questo si trasporta per il consumo nelle stalle. L'anidride solforosa, che ha pure il vantaggio di essere sostanza facilmente eliminabile, come vediamo nelle sue applicazione enologiche, dovra certamente impedire che nell'insilato, al momento del consumo, si generino sostanze fetide, o si moltiplichino germi patogeni.

Il difficile, nel caso dell'anidride solforosa, sta nel modo come opportunamente amministrarlo al foraggio quando viene riposto nel Silo. E forse questa la ragione per la quale il Grete stesso non diede seguito alle sue prime esperienze. Val certo la pena che l'attenzione degli sperimentatori agrari nelle regioni tropicali e sub-tropicali sia richiamata su questa interessante applicazione. In Tunisia nel 1910, assieme con altri antisettici, si è sperimentata l'azione dell'anidride solforosa, per impedire l'ammuffimento ed altre alterazioni nelle sanse di uliva, serbate per l'alimentazione del bestiame [18].

Trattamento con acidi, specialmente minerali, o con sostanze minerali acide.—La proposta di adoperare gli acidi in generale, ed in particolar modo gli acidi minerali, per la conservazione dei foraggi dentro i Silo, fu fatta dallo scrivente molti anni or sono a Portici, presso Napoli. Egli così scriveva nel 1885: —

" L'azione conservatrice degli acidi sulle sostanze vegetali, mi ha suggerito una nuova pratica nella preparazione dei foraggi infossati nei Silo.

" Durante l'infossamento è uso mescolare il foraggio verde con sale comune. Oltre al sale, io ho aggiunto acido citrico, od acido tartarico, od anche cremortartaro. Questi acidi meglio assicurano la conservazione del foraggio, e preparano alimento sano e gradito pel bestiame.

" Nelle prime mie esperienze, fatte col Professore Moldo Montanari, conservando mais da foraggio dall'agosto 1885 al marzo 1886, i resultati sono stati soddisfacenti: per noi e pel bestiame.
specialmente utile per l'Italia meridionale e per tutti i

" Gli agricoltori dovrebbero tentare questo metodo, paesi caldi. Nei quali i Silo potrebbero tanto bene servire per conservare foraggio fresco primaverile fino ai mesi più caldi dell'estate, quando è tanta penuria di foraggio. Il difficile, nell'arte dei Silo, è d'impedire il guastarsi del foraggio fresco, così proclive a fermentare rapidemente e a putrefarsi, specialmente durante il caldo estivo.

" La presenza degli acidi impedisce, o grandemente mitiga, queste nocive alterazioni nel Silo, dovute ad attività microbiche.

" Collo stesso metodo si potrebbero conservare foglie di gelso per i bachi da seta.

" Gli acidi minerali hanno azione più conservatrice, e sono molto meno costosi che gli acidi vegetali. Il solo acido minerale che si potrebbe consigliare, per conservare i foraggi, sarebbe l'acido cloridrico molto diluito. Prima di darne al bestiame bisognerebbe bagnare via via le porzioni del foraggio acidificato con soluzione di carbonato sodico. L'acido cloridrico sarebbe così neutralizzato, ed il foraggio resterebbe condito di cloruro sodico, o sal comune " [19].

In queste prove (nelle quali il mais infossato veniva anche protetto, nel fondo e nel colmo del Silo, con fogliame di eucalipto e di pino), la quantità insilata era di Qli. 48 di foraggio fresco, coll'aggiunta, oltre al sal comune, dei due acidi organici, nella proporzione di 200 gr. di cremor tartaro e di 200 gr. di acido citrico per ogni strato di due Qli. di foraggio trinciato: complessivamente nella proporzione del 2 per cento. Durante i sei mesi d'infossamento, la perdita in peso, in rapporto al mais verde primitivo, si calcolò al 12·1 per cento. Nella vicina prova di confronto, con foraggio semplicemente salato, la conservazione ed il calo furono quasi le stesse. Gli acidi organici non avevano influito in modo palese.

Una seconda prova fu fatta, sostituendo agli acidi organici l'acido cloridrico. Questo acido si adoperava in soluzione diluita al $\frac{1}{200}$, spruzzandolo con un grosso aspersorio sopra ogni strato di 2 Qli. di foraggio, via via che questo si veniva stratificando nel Silo. La durata dell'insilamento fu anormale, il Silo essendo rimasto chiuso per ben 18 mesi, dall'agosto 1886 al marzo 1888. La quantità di mais verde insilato e trattato coll'acido cloridrico era di Qli. 45·20. Per confronto, un Silo simile fu riempito con Qli. 40·40 dello stesso foraggio trinciato, colla sola aggiunta di sale pastorizio (125 gr. per Ql.).

Dopo 18 mesi di conservazione, il foraggio era in ottimo stato, le diminuzioni in peso determinate dal Professore M. Montanari essendo poco differenti nelle due prove: del 21·70 per cento nell'insilato con sale, e del 21·74 per cento nell'insilato coll'acido cloridrico. Vi era però, nel foraggio cloridrico meno acidità che nell'insilato col sale, questo essendo andato più soggetto ad alterazione acetica, nel mentre che nel foraggio cloridrico era palese il predominio della fermentazione alcolica. Dopo l'apertura dei Silo, per circa un mese, i foraggi vennero regolarmente consumati dal bestiame senza che si osservassero inconvenienti e senza che fosse necessario di neutralizzare il foraggio cloridrico [20].

L'azione dell'acido cloridrico è evidentemente limitata, non arrivando forse abbastanza ad impedire le alterazioni enzimiche. Nelle nuove esperienze su questo argomento, bisognerà adoperare dosi più forti di acido cloridrico che quelle adoperate nelle prove preliminari di Portici, non pretendendo ad una lunga durata nell'azione protettiva, tale da oltre passare quei pochi mesi che si richiedono nella pratica agraria.

L'acido, infatti, tende gradatamente ad esser neutralizzato, forse combinandosi coll'ammoniaca e colle basi derivanti dai processi proteolitici. In una prova con trifoglio incarnato, non trinciato, conservato in Silo per oltre 4 anni, dal 1888 al 1892, l'acido cloridrico non valse più ad impedire il guastarsi del foraggio. In questo caso Qli. 27·68 di trifoglio fresco erano stati trattati con 20 litri di acido cloridrico commerciale, diluito a 200 litri di soluzione acquosa. Durante i quattro anni di permanenza nel Silo l'acidità era scomparsa.

Non bisogna dunque preoccuparsi tanto di una possibile soverchia acidità (che si dovrebbe poi neutralizzare quando si amministra il mangime) all'apertura del Silo, quanto di adoperare nel riempire il Silo una proporzione di acido cloridrico sufficiente per assicurare una buona acidità iniziale.

Si consiglia in molti casi (e questo consiglio può meglio valere per climi caldi) di intridere bene con acqua il foraggio verde prima di chiudere il Silo, collo scopo di escludere meglio l'aria e mantenere succulento l'insilato: sarebbe bene che questa acqua fosse acida con acido cloridrico.

Il combinare l'azione dell'acido cloridrico con quella dell'anidride solforosa (mercè il bisolfito sodico) è forse un suggerimento che potrebbe riuscire utile per le ulteriori prove [21].

Una recente prova dell'utilità delle sostanza acide minerali, quando adoperate per la conservazione dei foraggi insilati, è fornita dalle esperienze del 1912, a Perugia, del Professore G. Sani. Egli adoperava fosfato mo nocalcico, finamente polverizzato, col quale cospargeva del trifoglio nella proporzione di 300 gr. di perfosfato per Qli. di foraggio verde, via via che questo si andava stratificando in un grande Silo di lamiera di ferro. Il perfosfato mediante la sua acidità, attenuava la temperatura nella fermentazione iniziale, impedendo che il foraggio si alterasse. Infatti, dopo undici mesi di conservazione il foraggio inacidito col perfosfato, oltre all'avere esternamente l'aspetto di foraggio fresco, manteneva inalterati nei suoi tessuti i granuli di amido. La perdita complessiva nel trifoglio trattato con perfosfato calcico fu del 13·70 per cento, mentre nella prova di confronto, dell'insilamento normale, la perdita fu del 18·68 per cento. Mentre nel trifoglio originario la proporzione di materia secca era del 27·61 per cento, nel trifoglio insilato col perfosfato la materia secca era del 28·32 per cento; infine, nell'insilato semplice questo percentuale della materia secca era ridotta al 23·99 per cento [22].

Gli esperimenti del Sani sono doppiamente istruttivi inquantochè consigliano l'uso di una sostanza acida che è facilmente alla mano nelle campagne e dimostrano come con essa si possa bene conservare uno dei foraggi verdi più renitenti allo insilamento.

Le esperienze di H. Weiske, nel 1885, ricordate da O. Kellner, hanno dimostrato che una certa proporzione di acidi minerali aggiunti ai mangimi non esercita azione nociva sul bestiame, quando beninteso non oltrapassi certi limiti. Egli paragonava del fieno ordinario da prato, amministrato allo stato semplice ad alcune pecore, con lo stesso fieno inumidito con acido solforico diluito (grammi 7·5 di anidride solforica per 1 Kgr. di fieno); in ambedue i casi le pecore digerivano ugualmente il foraggio. Nel rumine, l'acidità dei mangimi viene del tutto, od in gran parte, neutralizzato dalla alcalinità predominante in quel primo stomaco dei ruminanti [23].

Si comprende come una eccessiva acidità dovrebbe riuscire dannosa; ma in tale caso sarebbe facile neutralizzare l'acidità, al momento del consumo, aspergendo il foraggio con carbonato di sodio, oppure semplicemente con del calcare in polvere. L. Frank esperimentava recentemente per dimostrare l'utilità, nel caso delle vacche da latte, di mescolare col foraggio ordinario dal calcare polverizzato, collo scopo speciale di correggere nel latte la deficienza in calce [24].

Dovendo scegliere fra i due acidi minerali, cloridrico e solforico, crederei che la preferenza si dovrebbe dare al cloridrico, inquantochè è l'acido che si trova naturalmente nel succo gastrico e che perciò è più adatto ad agevolare la digestione. Inoltre, neutralizzando questo acido, si generano cloruri; i quali sempre nei mangimi si debbono preferire ai solfati. Recenti osservazioni, a Porto Rico tendono a dimostrare la utilità nello sviluppo del bestiame bovino dell'aggiunta ai mangimi usuali di piccole quantità di cloruro di calcio [25].

Il cloruro sodico, poi, oltre all'essere un costituente normale ed importante nell'alimentazione degli erbivori, avrebbe anche un'azione specifica, non bene spiegata, nell'impedire l'azione nociva di alcune tossine, che si possono generare nell'insilamento, almeno nel caso delle polpe di barbabietola. Nelle importanti ricerche, fatte nel 1893 di S. Arloing, sul potere patogeno dell polpe di barbabietola insilate, si trovava che l'aggiunzione a queste polpe del 0·20 o 0·25 per cento di cloruro sodico sarebbe il metodo più semplice e meno costoso per eliminare le tossine che cagionano nel bestiame la "malattia della polpa" [26].

Valga il presente scritto a richiamare l'attenzione degli studiosi dell'agricoltura dei paesi caldi alla importante questione della conservazione dei foraggi succulenti ed al buon utilizzamento, come mangimi, di piante spontanee e di residui vegetali facilmente alterabili. Coll'uso di antisettici acidi, oppure di solfuro di carbonio e di anidride solforosa, non dovrebbe essere tanto necessario di costruire grandi e costosi Silo, la efficacia degli antisettici potendo manifestarsi ugualmente bene in Silo relativamente semplici e di costruzione poco costosa [27].

Le cose esposte non possono costituire ancora dei suggerimenti diretti per la pratica agraria; sono piuttosto stimoli a nuovi e più estesi esperimenti, dai quali con sicurezza la pratica coloniale potrà attingere norme utili e di larga applicazione.

La bibliografia che segue può bene servire di base a questi nuovi studi.

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[1] Per un assieme di dati comparativi fra insilato e fieno, vedasi: F. H. Storer, *Agriculture in some of its relations with Chemistry*, seventh edition, vol. iii, New York, 1906.

O. Kellner, paragonando le perdite che subiscono la materia secca e la digeribilità dei proteici, nella fienagione e nell'insilamento, conclude che l'insilamento (egli scrive in Germania) va

limitato soltanto ai foraggi di minor valore; cioè a quei foraggi che, a seconda delle condizioni climatiche, non si potrebbero meglio utilizzare.

O. KELLNER. *Die Ernährung der landw. Nutztiere.* Berlin, 1905, p. 239.

E specialmente nei climi poco umidi e soggetti a lunghi periodi di siccità, che l'insilamento ha reso meno costosa la produzione del latte.

GUY S. ELLIS. "Silage as Feed for Dairy Cows." *Journ. Dept. of Agric. of South Australia,* February, 1913, p. 800.

Peri i climi umidi, nel paragone fra insilamento e fienagione, valgono sempre le considerazioni finali della minuziosa e diligente relazione di H. M. Jenkins :

H. M. JENKINS. "Report on the Practice of Ensilage at Home and Abroad." *Journ. of the Roy. Agric. Soc. of England,* April, 1884, Part I, xx, p. 126.

Vedasi anche, sempre per un clima molto umido :

JOHN SPEIR. "Silage versus Hay." *Trans. of the Highland and Agric. Soc. of Scotland,* 1889, p. 82.

Però, varie indagini nell'Inghilterra, in vista della produzione del latte, tendono ad essere più favorevoli per l'insilamento che per la fienagione. Vedansi le indagini della Commissione Reale sui vantaggi dell'Insilamento per il Lattificio, riassunte da :

CH. S. PLUMB. "Silos and Silage." *Canadian Agric. Annual,* 1905, p. 88.

Passando poi a relazioni che si riferiscono a paesi sub-aridi, più decisamente prevalgono le opinioni in favore dell'insilamento :

"Farmers' Opinions on Silage." *Farmer and Breeder,* Sioux City, Iowa, February 29, 1912; *Journ. Dept. of Agric.,* Victoria, Melbourne, 1912, vol. x; riportato in *Bull. de l'Inst. Intern. d'Agric.,* Rome, Mai 1912, p. 812.

Anche per la produzione della carne alimentare di bovini, si va vieppiù palesando il vantaggio economico dei silo nei paesi sub-aridi :

R. S. CURTIS. "Economic Importance of Corn Silage in Southern Beef Production." *North Carolina Agric. Stat. Reports,* 1912; Breve accenno in *Exp. Stat. Record,* July, 1913, p. 69.

[2] Le perdite nella fienagione si debbono calcolare dal momento della falciatura. O. Kellner calcola, per la Germania, che di rado la perdita di sostanza secca oltrepassa il 20 per cento. Le perdite maggiori sono con fieno di leguminose. Nei climi caldi ed aridi le perdite debbono essere ben forti e le spese anche non lievi. Vedi :

J. A. VOELCKER. *Improvement of Indian Agriculture."* Calcutta, 1897, p. 179.

[3] Solo in questi ultimi anni si estende nelle colonie australiane la pratica d'insilare i foraggi, essendo preferita la

conservazione dentro grande silo verticali, a barile, costruiti principalmente di legno (*Overground tub-silos*).

P. H. SUTER. "The Conservation of Green Fodder as Ensilage." *Journ. Dept. of Agric. of South Australia*, August, 1906, p. 6.

Nel New South Wales, nel 1909, si aveveno silo in 364 poderi, con una produzione complessiva di 34,847 tonn. d'insilato. Nel 1904 questa produzione era di 12,609 tonn.

Bull. Imperial Institute, 1912, x, p. 313.

Le difficoltà nel conservare il foraggio nei climi caldi, senza andare incontro a notevoli perdite di materiale, devono aver reso dapprima lenti e dibbiosi gli agricoltori nell'adottare questa pratica, come è avvenuto, ed avviene ancora, in Italia, malgrado il buon esempio di alcune scuole, specialmente dell'Istituto Agrarie della Università di Pisa, dove da oltre venti anni la conservazione del mais e della saggina entro un silo in muratra viene ogni anno praticata dal Prof. Girolamo Caruso.

In Australia l'uso dell'insilamento già incominciava ad entrare nella pratica comune verso il 1890. Ben più lento che nell' Australia è stato l'estendersi di questa pratica nel Sud-Africa, dove oggi però incomincia ad essere molto apprezzata. Si confrontino:

A. C. MACDONALD. *Ensilage, or the Preservation of Green Fodder.* Capetown, 1893.

J. BURTT-DAVY. "The Preservation and Use of Maize for Stock Feed." *South African Agric. Journ.*, January, 1913; riassunto in *The Tropical Agriculturist*, Ceylon, March, 1913, p. 130.

Per altre notizie sull'estendersi e sulla utilità e sulle difficoltà dell'insilamento in climi caldi ed anche abbastanza aridi, vedi:

MAURICE MONTET (Directeur du domaine de Sidi-Bu-Hadid). "L'Ensilage en Vert des Fourrages en Tunisie." *Journ. d'Agric. Tropicale*, Avril 1908, p. 111. Il Montet considera che in Tunisia l'insilamento possa riuscire proficuo solo per i foraggi di minima valore.

"Création de réserves fourragères chez les indigènes." *Bull. Direct. Agric.*, Tunis, 1898, iii, p. 62.

F. MALET. "A propos de l'Ensilage. Analyse de l'Ensilage de Sidi Salem." *Idem*, 1897, ii, p. 48.

RIBAN. "L'Ensilage en Tunisie." *Idem*, 1897, iii, p. 530.

"L'Ensilage en Tunisie." *Idem*, 1897, iii, p. 310.

MINANGOIN. "Note sur l'Ensilage, Tunisie." Idem, 1896, i, p. 29.

P. ROBINET. "Les réserves fourragères et l'ensilage en Tunisie." *Bull. Agric. Alger-Tunis*, 1902, p. 311.

DESMOULINS. "Ensilage des pampres de Vigne." *Idem*, 1905, i, p. 378.

"Ensilage en Algérie." *Bull. Off. Gouv. Gén. Algérie*, 1911, N. 15.

W. F. MASSEY. "Ensilage Up-to-date" (in N. Carolina). *Agric. Journ.*, Cape Colony, 1898, xiii, p. 831.

Lo sperimentatore americano arriva a togliere persino la pressione sopra il foraggio insilato.

Nel North Carolina vedansi le recenti esperienze di R. S. CURTIS (1913); Nell' Alabama (1913); e nel Texas (1913) di J. C. BURNS e T. P. METCALFE.

Vedansi anche :

C. K. MACLELLAN. *Silos, Silage and Silage Crops for Hawaii.* Honolulu, 1913.

[4] A. D. HALL. *An Account of the Rothamsted Experiments*, London, 1905, p. 266. Gli esperimenti a Rothamsted sull' insilamento furono incominiciate da J. B. Lawes e J. H. Gilbert nel 1884. Vedansi le varie relazioni nel *Journal of the Royal Agric. Society of England.*

V. ALPE ed A. MENOZZI. *Ricerche sull' Infossamento dei Foraggi Verdi.* Ricerche del Laboratorio di Chimica Agraria della R. Scuola Sup. d'Agric. di Milano. Milano, 1898. Le prove furono fatte nel 1891-92.

GIROLAMO CARUSO. "Esp. sulla conservazione dei foraggi freschi colla pressa Blunt." *Atti R. Accad. dei Georgofili,* 1891, xiv, p. 131.

[5] H. E. ANNETT ed EDW. J. RUSSELL. "The Composition of Green Maize and the Silage produced therefrom." *The Journ. of Agric. Science,* Cambridge, 1907-08, vol. ii, p. 382.

J. H. KING. "Influence of Close Packing on Unavoidable Losses in Silage Fermentation." *Twentieth Ann. Report of the Agric. Exp. Stat. of the Univ. of Wisconsin,* Madison, 1904, p. 249. In silo metallico, King ridusse le perdite all' 1 per cento.

LAFAR. *Technisch. Mykologie,* Jena, 1908, vol. ii, p. 332. Calcola che in pratica le perdite coll'insilamento siano dall 10 al 30 per cento. Egli non vede con quale metodo sia possibile diminuire queste perdite.

S. M. BABCOCK ed H. L. RUSSELL (*Farmers' Bull.* No. 113, Washington, 1901), trovarono che le perdite nell'insilamento poterono variare dell' 1 per cento al 40 per cento, le variazioni dipendendo principalmente dalla esclusione dell' aria. Secondo King, nella buona pratica, (nell' Wisconsin) le perdite inevitabili potrebbero essere ristrette nei limiti del 4 all' 8 per cento.

Vedansi anche le perdite coll'infossamento riportate da F. H. STORER (*loc. cit.*). Con insilamento di leguminose le perdite possono essere ingenti : del 56 per cento con lupini, del 27 per cento con medica, del 31 per cento con trifoglio.

Gisevius, come riporta Wölfer, calcolava che nll'infossamento ben condotto la perdita in sostanza alimentare è fra $\frac{1}{8}$ e $\frac{1}{3}$; nell'infossamento poco accurato da $\frac{1}{2}$ a $\frac{2}{3}$; nel silo a mucchio compresso $\frac{1}{2}$, oltre al deterioramento nutritivo. Invece nel caso della fienagione, Gisevius calcola che questa perdita, con stagione favorevole, è da $\frac{1}{10}$ ad $\frac{1}{7}$; e con stagione contraria, da $\frac{1}{4}$ ad $\frac{1}{3}$.

WÖLFER. *Grundsätze u. Ziele neuzeitlicher Landwirtschaft,* Berlin, 1911, p. 276.

[6] D. FERUGLIO e L. MAYER. *Richerche chimiche sull' Infossamento del Mais,* Udine, 1911.

DOMENICO FERUGLIO. "Stato attuale delle conoscenze sull'infossamento dei foraggi." *Atti del II Congresso Nazionale di Chimica Applicata, Torino, Sett.* 1911, Torino, 1912, p. 396.

[7] In riguardo alla produzione di ammoniaca nel foraggio insilato, vedi:

O. KELLNER and SAWANO. "Unters. über die Veränderungen der Futtermittel beim Einsauern in Nicten." *Landw. Vers. Stat.* 32, pp. 57-71 (Esperienze a Tokio).

E. KAYSER. *Microbiologie Agricole* (*Encyclop. Agricole*), Paris, n.d. p. 341. Ivi si rammentano le ricerche di GIRARD e H. COUDON; i quali connettono le produzione di ammoniaca coll'attività microbica. Essi avrebbero constatato che la produzione di sali ammonici può corrispondere a circa il 23 per cento dell'azoto totale. L'ammoniaca prodotta in una parte del silo può arrivare a neutralizzare l'acidità dell'insilato in altre parti del silo, e così aumentare le cause di attrazione e di perdita nella massa insilata.

Secondo E. J. Russell la produzione dell'ammoniaca sarebbe indipendente dalle azioni bacteriche:

EDW. J. RUSSELL. "The Chemical Changes taking place during the Ensilage of Maize." *Journ. of Agric. Sci,* 1907-08, ii, p. 392.

[8] FR. TANGL u. STEPHAN WEISER. "Unters. über die Veränderungen des Nährwertes des Futters beim Einsauern und über die dabei auftretenden Verluste an Nährstoffen." *Landw. Vers. Stat.* 74, 1911, pp. 263-342. Nelle loro ricerche questi autori dimostrano che nella perdita di sostanza secca che ha luogo nell'insilato, circa $\frac{3}{4}$ è di sostanza digeribile, e solo $\frac{1}{4}$ di sostanza non digeribile; questo nel caso dell'erba medica. E soltanto nell'insilamento degli stocchi di granturco che gli sperimentatori ungheresi trovano maggior vantaggio che nel semplice disseccamento.

D'altra parte, va ricordato che nell'Ungheria, paese ad estate molto siccitosa, la pratica dell'insilamento è da lungo tempo, prima che in molte altre parti di Europa, trovata vantaggiosa. Vedi:

JOHN WRIGHTSON. "System of making Sour Hay." Report on the Agriculture of the Austro-Hungarian Empire, *Journ. Roy. Agric. Soc. of England,* 1874, x, Part II, p. 351.

[9] J. A. VOELCKER. *Improvement of Indian Agriculture,* p. 364. E evidente che le forti perdite osservate durante il primo periodo nel quale si sperimentò l' insilamento nell'India sono dovute in parte alla tendenza di preferire l'insilato *dolce* a quello *acido,* e più ancora alla non buona costruzione dei silo e all' incuria al momento del consumo. Il Dr. Leather osserva come

sia frequente l'ammuffire dell'insilato. Il quale ammuffimento avviene facilmente in clima caldo, quando il foraggio insilato non è bene difeso dalla lenta evaporazione, od è premuto da soverchia pressione.

LEATHER. "Silage-making in India." *The Agric. Ledger*, Calcutta, 1894.

Più che Voelcker e Leather, R. WALLACE (*Indian Agriculture*, p. 289) era persuaso della utilità dell'insilamento nelle condizioni climatiche dell'India. Nell'India l'uso dell'insilamento si va gradatamente estendendo. Per questa pratica, tanto utile nei paesi caldi, è interessante una nuova forma economica del silo, costruito a forma di torre, con intreccio di bambù.

BERNARD COVENTRY. "The Bamboo Wattle Silo: An Attempt to Construct a Cheap Indigenous Silo." *Agric. Journ. of India*, January, 1911, p. 20.

Un silo come quello proposto dal Coventry (quando non favorisca l'essiccamento dell'insilato, la qual cosa sarebbe dannosa) dovrebbe riuscire utile, specialmente quando si adotti un sistema di difesa del foraggio come quelli proposti nel presente scritto; mediante i quali la inalterabilità del insilato si ottiene, non solo colla esclusione dell'aria, ma modificando fin dallo inizio le condizioni chimiche della massa insilata.

[10] A. L. KNISELY. "Steaming Silage." *Oregon Agric. Stat. Reports*, 1903 e 1905. Vedi anche:

Ex. Stat. Record, vol. xiv, p. 278; vol. xvi, 1904-05, p. 101; vol. xix, 1907-08, p. 28.

E. J. RUSSELL. *Chemical Changes, &c. Loc. cit.*, p. 396.

In riguardo alla termo-resistenza di alcuni bacteri dei silo, in particolare delle polpe di barbabietola, vedansi le recenti ricerche di Costantino Gorini:

COSTANTINO GORINI. *Ricerche bacteriologiche sui foraggi in Silo.* Relazione Sesta, Milano, 1912.

[11] G. LECHARTIER. "Sur la fermentation et la conservation des fourrages verts en silo." *Annales Agronomiques*, 1881, vii, p. 481.

S. M. BABCOCK and H. L. RUSSELL. "Causes of Silage Fermentation." *Twentieth Ann. Report of the Agric. Exp. Stat. of the University of Wisconsin*, Madison, 1904, p. 243.

E. J. RUSSELL. *Loc. cit.*, 1908.

[12] L'acido lattico cessa di formarsi quando l'acidità che si va accumulando nei liquidi dove agiscono i fermenti lattici raggiunge un'acidità di circa 1·5 per cento espressa in acido lattico.

Nel foraggio insilato l'acidità che si osserva quando l'insilato si estrae dal silo è molto variabile. Dipende principalmente dalla quantità del foraggio, edal metodo seguito al momento d'insilare. L'insilato *dolce* è meno acido di quello *acido*. Dipende anche dal foraggio che si conserva: quelli più zuccherini danno acidità più alte che; foraggi molto azotate di leguminose;

in questi ultimi casi l'insilato può ridursi ad essere neutro ed anche alcalino, e quindi alterabilissimo. La durata dell'insilamento pure influisce, poichè colla produzione graduale di ammoniaca e di composti basici, gli acidi prodotti originariamente si vanno neutralizzando.

Il modo stesso seguito per determinare l'acidità può dare risultati molto differenti, piochè evidentemente vi sono nei foraggi insilati delle sostanze basiche, aderenti od immedesimate nei tessuti che difficilmente si lasciano estrarre con acqua, ma che debbono costituire un sottostrato piùttosto favorevole allo sviluppo di quei bacteri della putrefazione che guastano e rendono poco gradito al bestiame l'insilato. Cosi, G. Appiani osservava che nei foraggi insilati l'acidità determinata estraendo il campione sottoposto ad esame con una soluzione alcalina titolata può indicare una acidità 3 a 4 volte maggiore di quella che si trova col metodo usuale di estrarre il campione con acqua e nell'estratto acquoso determinare l'acidità.

Storer (*loc. cit.*) dice che l'acidità dell'insilato varia da 0·02 al 2 per cento, avendosi anche dei casi di foraggio neutro ed alcalino.

Nelle determinazioni di Menozzi, Appiani etc. (*loc. cit.*) l'acidità fissa, espressa come acido lattico, variava da 0·10 ad 1·18 per cento; e quella volatile, espressa come acido acetico, da 0·10 a 0·67 per cento.

G. Sani in un trifoglio insilato assieme con per fosfato, trova un'acidità, espressa come acido lattico, di 0·549 per cento.

Annett e Russell (*loc. cit.*) calcolando l'acidità in termini di acido solforico, trovano nell'insilato di mais un' acidità totale di 0·58 per cento, della quale 0·49 fissa e 0·09 volatile.

Esten e Mason, nel Connecticut, in osservazioni ripetute durante 5 anni, trovarono che l'acidità degl'insilati di granturco restava quasi costante intorno all' 1 per cento, benchè qualche volta oltrepassasse il 2 per cento.

W. M. ESTEN and C. J. MASON. "Silage Fermentation." *Storr's Agric. Stat. Connecticut Bull.* 70. Riassunto in *Exp. Stat. Record,* 1912, vol. xxvii, p. 204.

Si comprenderà l'importanza di questi dati per aver un criterio abbastanza sicuro intorno al grado di acidità che si dovrebbe dare all'insilato, al momento della chiusura del silo, per assicurarne una sicura conservazione.

[13] STAN. EPSTEIN. "Ueber die saure Gärung von Rübenschnitzeln." *Centralb. f. Bakteriologie,* 1902, ii abt., 8, 766; riass. in *Jahresb. Agr. Chemie,* 1902, v, p. 303.

COSTANTINO GORINI. "Studi batteriologici sopra i foraggi infossati." *Ann. Ist. Agr. Ponti,* Milano, 1901-1905.

COSTANTINO GORINI. "Ricerche batt. sui foraggi conservati nei silos." Relaz. terza, *idem,* Milano, 1908. Dopo lo studio della microflora di varie qualità di foraggi insilati, Gorini tende a credere che per assicurare un insilato normale, ci voglia il predominio di una flora bacteria normale. Indi l'idea dell'impiego di fermenti telezionati.

L. MALPEAUX. "Conservation des Pulpes par les Ferments lactiques." *Journ. Agric. prat.*, 1910, ii, p. 303.

L. MALPEAUX et G. LEFORT. "Ensilage des Fourrages, des Racines, et des Pulpes. Emploi des Ferments lactiques." *Journ. Agric. prat.*, 1911, ii, p. 488. Ricordano come Mazé, nel 1905 (*Annales de l'Inst. Pasteur*, 1905, xix, p. 378) avesse indicato come ogni sostanza ricca in carboidrati fermentescibili si potesse proteggere contro i fermenti della putrefazione seminandola con fermenti lattici.

L. MALPEAUX et G. LEFORT. "L'Ensilage des Pulpes et l'emploi des ferments lactiques." *Journ. Agric. prat.*, 1912, ii, p. 590.

COSTANTINO GORINI. "Ricerche di Batteriologia agr. sui foraggi conservati nei silo." Sesta Relaz. *Ann. Inst. Agr. A. Ponti*, Milano, 1912. Vi è il resoconto di una prova fatta a Piacenza, assieme col Prof. Zago, confrontando un insilato normale di erba con insilato simile seminato colle colture littiche del Gorini, facendo vantaggiosamente prevalere i fermenti lattici nella microflora dell'insilato.

F. LÖHNIS. *Vorlesungen über landw. Bakteriologie*, Berlin, 1913, p. 218.

Esten osservava, nel Connecticut, i vantaggi dell'usare culture pure di bacteri acidificanti per ottenere che in 24 ore l'insilato fresco fosse bene acidificato. Si inocularono 3,000 tonn. di insilato di mais, il quale maturò a foraggio, con grato odore, con un anticipo di tre a quattro settimane nella maturazione.

W. M. ESTEN. "Maize Silage in Connecticut." *The Connecticut Farmer*, New Haven, March 11, 1911. Riportato in *Bull. Rens. Agr., Inst. Intern. d'Agr.*, Rome, Août, 1911, N. 1,155.

WÖLFER (*loc. cit.*, p. 276), accenna all'uso di irrorare con latte acido l'insilato mentre si stratifica nel silo, per meglio assicurare il prevalere dei bacteri acidi.

[14] SAMARANI, in *Annuario della R. Stazione di Caseificio di Lodi per il* 1910, Lodi, 1911. Citato in D. FERUGLIO, *loc cit.*, p. 400.

[15] LÖHNIS. *Loc. cit.*, p. 220.

[16] A. GRETE. "Schwefelkohlenstoff beim Einmachen von Grünfutter" (*Schweizerisches landw. Centralbl.*, Jahrg, 1886, N. 1), *Beidermann's Centralbl. der Agrikulturchemie*, 1886, xv, p. 355.

A. GRETE (o Gretel). "Ein Versuch zur Konservirung von Grünfutter mittelst Schwefelkohlenstoff" (*Milchzeitung*, 1889, xviii, N. 13), *Biedermann's Centralbl. der Agr. Chemie*, 1889, xviii, p. 502.

In un silo della capacità di m.c. 4·32, pieno di buon trifoglio, aggiungeva kgr. 2 di solfuro di carbonio. In silo simile, pieno di erba di prato, aggiunse kgr. 3·5 di solfuro di carbonio.

Chi riferiva temeva che il metodo dovesse essere troppo costoso.

Questo nel 1889; ma dopo il 1901, la preparazione del solfuro di carbonio con forni elettrici ha reso questo prodotto molto meno costoso. La fabbrica a Penn Yan, nello Stato di New York, fabbrica oggi solfuro di carbonio col metodo di E. R. Taylor, nella proporzione di 14,000 libbre inglesi nelle 24 ore, e ne potrebbe fabbricare 25,000 libbre.

Per un riassunto del metode di Grete, vedasi anche:

A. GRETE. "Conservazione di foraggi verdi mediante il Solfuro di Carbonio." *Giorn Staz. agrarie ital.*, 1890, xviii, p. 201.

F. KALUGIN and S. PARASHCHUCK. *The Influence of Carbon Disulphide and Common Salt on the losses of Nutrients and the Character of the Fermentation of Ensiled Fodders.* Riassunto in *Exp. Stat. Record*, 1901, xii, p. 822.

[17] B. GÖRNER. (*Zeitschr. d. Spiritusindustrie*, 1891, p. 395), *Jahresb. d. Agrikulturchemie*, 1891, xiv, p. 724.

[18] L'obbiezione maggiore all'uso dell'anidride solforosa od a solfiti o bisolfiti, sarebbe della possibile azione tossica di questa sostanza. Se per l'alimentazione umana conviene essere severi nel limitarse la quantità nelle bevande e nei sciroppi, tale severità non sarà forse tanto necessaria nell' alimentazione de' bovini. Ma è solo la sperimentazione che potrà stabilire i limiti, come si è fatto nel caso dei mosti e dei vini.

In riguardo all'uso dell'anidride solforosa per conservare mangimi di sansa in Tunisia, vedi: *Bull. Dir. Agric. Tunis*, 1910, xiv, p. 476; riassunto in *Exp. Stat. Record*, Washington, 1911, xxv, p. 575.

[19] ITALO GIGLIOLI. *Igiene Antimicrobica*, Napoli, 1887, p. 400.

[20] MOLDO MONTANARI. "Due prove dell'Infossamento del Mais foraggio col Silo Goffart, compiute nell'Orto Agrario della R. Scuola Sup. d'Agricoltura in Vortici, dal 1885 al 1888. *Annuario della Scuola di Portici*, 1890-91 vi, Portici, 1891.

Vedi anche: *Staz. Agr. ital.*, 1892, xxiii, p. 518.

[21] Secondo Cohn, basa una Soluzione di 0·7 per mille di acido cloridrico per completamente arrestare la fermentazione lattica.

Nel foraggio appena trinciato si fa più intenso il processo respiratorio ed il consumo di sostanza vegetale. Colla immediata aggiunta della soluzione cloridrica questo inutile spreco della sostanza più nutriente del foraggio si risparmierebbe.

L'aggiunte di acqua si fa per rendere più compalta e meno aperta all'azione dell'aria la massa insilata, nel caso di foraggi voluminosi e piùttosto secchi. L'aggiunta di piccole porzioni di bisolfito sodico, sparse nell'insilato prima di aggiungere l'acido cloridrico, accrescerebbe di molto l'azione antisettica di questo, paralizzando forse del tutto la respirazione cellulare, causa principale di consumo di materia secca nel foraggio appena insilato. Vedi, per es.:

O. L. REED and J. B. FITCH. "Sorghum Crops for Silage."

Kansas State Agric. Coll. Exp. Stat. Circular 28, 1913; riassunto nel *Bull. dell' Inst. Intern. di Agricoltura,* Ott., 1913, N. 1,172.

[22] GIOV. SANI. "Azione del Fosfato monocalcico nella conservazione del foraggio verde." Rendiconti *R. Accad. dei Lincei,* Roma, luglio, 1912, vol. xxi.

[23] H. WEISKE, B. DEHMEL, G. KENNEPOHL, B. SCHUTZE u. E. FLECHSIG. "Einfluss von freier Säure auf die Verdauungsvorgänge sowie auf den Stickstoff- und Mineralstoffumsatz im Körper der Herbivoren. (*Journ. f. Landw.,* 1885, xxxiii, p. 21), *Jahresb. d. Agrikulturchemie,* 1885, p. 547.

L'esperienza, con pecore Southdown, si fece in tre periodi, alternando fieno normale con fieno solforico, e nel terzo periodo con fieno e magnesia. Nei tre periodi la digeribilità del fieno continuò uniforme. La proporzione non lieve di acido solforico non ebbe cattivo effetto.

Vedi anche: O. KELLNER. *Die Ernährung der landw. Nutztiere.* Berlin, 1905, p. 54. Kellner riporta alcune sue esperienze con pecore, alimentandole con foraggio acido, contenente 2·67 per cento di acido lattico.

[24] L. FRANK. "On the Influence of Feeds Poor in Lime upon the Lime-content in Cows' Milk." (*Chem. Zeitung,* 1910, xxxiv, p. 978), riassunto in *Exp. Stat. Record,* Washington, 1911, xxiv, p. 278.

[25] E. G. RITZMAN. "Silage in Porto Rico." (*Porto Rico Agric. Stat. Report*) *Exp. Stat. Record,* Washington, 1912, p. 872.

[26] S. ARLOING. "Recherches exp. sur le pouvoir pathogène des pulpes de Betteraves ensilées et sur le moyen de l'amoindrir." *Annales Agronomiques,* 1893, xix, p. 133.

[27] Mediante antisettici che, nello stesso tempo, impediscono l'azione bacterica e soffocano la respirazione delle cellules vegetali, sarà forse più facile conservare allo stato quasi normale alcuni foraggi caratteristici dei paesi più aridi, che per la loro forte succulenze mal si lasciano conservare nei silo. Tali sono gli articoli di fico d'India e di altre specie di cactus, i quali, come osservava J. W. Leather nell'India, molte volte si riducono nei sila ad un mucchio di fibre poco digeribili. Questi silo di cactus furono sperimentati presso a Madras.

J. W. LEATHER. "Silage-making in India." *Agric. Ledger,* No. 2, Calcutta, 1894, p. 4.

Nel New South Wales si considera che il metodo più pratico per utilizzare i cactus è di insilarli; poichè in pochi mesi gli aculei si rammolliscono e si ottiene un mangime abbastanza buono. (*Indian Agric.,* No. 2, February, 1909, vol. xxxiv), *Tropical Agriculturist,* Ceylon, June, 1910, p. 504.

Vedi anche, per il valore alimentare di questo foraggio: EMILE BAILLAUD, "Observations sur l'emploi des cactus dans l'alimentation du bétail." [Tunisie.] *Journ. d' Agric. Tropicale,* September, 1910, p. 261.

E. W. HORN and S. G. MUTKEKAR. "The Feeding of Prickly Pears." *Agric. Journ. of India,* April, 1914, p. 191.

LE LANE DELLA TRIPOLITANIA E MEZZI PER MIGLIORARLE.

Per il Dott. Alberto Caselli.

L'allevamento degli ovini ha importanza massima fra le industrie agrarie della Tripolitania nè potrebbe essere altrimenti in un paese in cui le terre a pascolo sono abbondantissime e dove la popolazione, indolente per natura, più che all'agricoltura meglio si dedica alla vita pastorale.

La qualità dei pascoli stessi costituiti principalmente da piante foraggere di scarso valore nutritivo consentono più che l'allevamento dei bovini e degli equini, quello degli ovini e dei caprini. Prima della guerra il commercio di esportazione degli ovini si aggirava intorno ai 100,000 capi che venivano diretti paricolarmente al mercato di Alessandria d'Egitto, mentre solo piccolissime quantità erano avviate a Malta e in Italia. Cli ovini rappresentano per la Tripolitania un capitale elevatissimo se considerato e paragonato al rimanente bestiame. Il loro numero supera certamente il milione e mezzo di capi raggruppati in greggi di varia entita a seconda del numero dei componenti la famiglia del pastore: in media i greggi sono costituiti da tre o quattrocento pecore ma non è raro il caso incontrare nei pascoli più ricchi della Tripolitania dei grossi greggi di 4,000 capi.

Razze ovino-tripolitane.—La pecora della Tripolitania, ed in generale quella del Nord Africa appartiene alla razza Siriaca varietà berbera; la sua conformazione subisce però molte modificazioni a seconda i luoghi che abita e le cure di cui è oggetto. Tuttavia il lipoma caudale rappresenta un carattere di altissima importanza etnica. La razza del Sudan, che trovasi rappresentata nelle regioni del Sud della Tripolitania, non ha alcuna importanza per la produzione della lana.

Le pecore della Tripolitania hanno bellissimo aspetto, sono coperte di abbondante vello e durante il periodo dei pascoli verdi presentano un ottimo stato di nutrizione.

Il vello ricopre generalmente tutto il corpo esclusa parte della testa, le gambe, la parte posteriore dell'addome, l'interno delle cosce, e la parte anteriore della coda; sarebbe di una sufficente uniformità e lo è effettivamente negli animali ben tenuti; ma la trascuratezza degli indigeni e le frequenti malattie della pelle non curate, lo rendono grossolano e in molte parti interrotto da larghe chiazze sprovviste di lana. Il vello si presenta aperto a bioccoli conici, più facile quindi ad insudiciarsi, diversamente impregnato di sego nelle varie regioni del corpo. Il mantello è di un biondo giallognolo con colorazione nera, marrone e rossiccia alla testa e alle estremità degli arti. Si fa una distinzione fra la lana proveniente dalla parte orientale della Tripolitania e quella dalla parte occidentale, ritenendosi la prima di qualità superiore e più adatta alla tessitura dei baracani. Negli animali in buona condizione di salute e di nutrizione la quantità di lana che si raccoglie da un vello non lavorato oscilla fra i tre e i quattro chilogrammi, ma in condizioni eccezionali, può raggiungere e sorpassare i sei Kg. La tosatura si effettua con un sistema poco razionale, mediante cioè una forbice grossolana e di grande dimensione la quale non permette che il vello sia tolto egualmente e per intero da tutta la superficie del corpo. Resta infatti della lana tagliuzzata in quantità rilevante che è sottratta al vello e venduta a bassissimo prezzo. La lana portata sul mercato dai proprietari è acquistata dagli indigeni e dai negozianti esportatori al prezzo di L. 80 al quintale se sudicia, e di L. 2.40 il chilogrammo se lavata e di buona qualità, però la maggiore quantità di lana che si trova sui mercati non è epurata. Anzi i pastori per farla aumentare di peso la bagnano con una piccola quantità di latte di buero e vi gettano sopra della sabbia. I negozianti esportatori sventano però abilmente questa astuzia e difficilmente acquistano anche, se offerte a buon prezzo, lane molto sudicie perchè in tal caso oltre a pagare della sabbia per lana dovrebbero sottoporle a frequenti battiture per attenuare il cattivo odore che emanano. Quando nella lana non si usano mezzi fraudolenti per renderla più pesante, la perdita di peso, nella lavatura a fondo varia dal 55 al 66 per cento.

Nell'esame di otto campioni di lana di pecore delle regioni del Tarhuna e del Cussabat si sono ottenute per lavaggio con acqua fredda e con etere le seguenti perdite in peso:

No. d'ordine	Lunghezza dei bioccoli	Caratteri fisici	Perdita per cento alla lavatura d'acqua	Perdita per cento all'azione dell'etere
			Per cento	Per cento
1	8	Molto ondulata	55	9·48
2	6	,, ,,	45	8·70
3	7	Ondulata	40	10·40
4	6	Ricca di giarra	49	11·10
5	9	Lucente ...	46	11·50
6	7	Molto ondulata	44	8·90
7	8	Ondulata	44	9·30
8	6	Scura ...	43	9·70

In queste lane l'impurità sono rappresentate principalmente da particelle terrose che vennero asportate con acqua corrente fredda. I campioni furono in seguito sottoposti all'azione dell'etere per determinare la quantità di grasso che contenevano. Pucci e Gugnoni dopo la lavatura di alcuni velli della Msellata ottennero i seguenti rendimenti:

No. d'ordine		Peso del vello: Prima del lavaggio	Peso del vello: Dopo il lavaggio con acqua fresca	Perdita	Reddito	Perdita
		Kg.	Kg.			
1	Vello di pecora (Cussabat)	3·0	1·300	1,700	43·3	56·6
2	,, ,, ,,	3·9	1·760	2·140	45·1	54·8
3	,, ,, ,,	3·8	1·300	2·500	34·2	65·7
4	,, ,, ,,	4·0	1·520	2·480	38·0	62·0
5	,, ,, ,,	2·7	1·060	1·640	39·2	60·7
6	,, ,, ,,	4·1	1·640	2·460	40·0	60·0
7	,, ,, ,,	2·9	1·300	1·600	44·8	55·1
8	,, ,, ,,	2·9	1·000	1·900	34·4	65·1

Qualità della lana.—Se la razza ovina della Tripolitania non lascia molto a desiderare per la quantità di lana che è in grado di fornire, altrettanto, non può dirsi per la qualità. Infatti la lana si presenta generalmente poco uniforme ed è costituita da fili non sempre dello stesso spessore e perchè questo varia sovente anche lungo il medesimo filo, ora più grossa alla base ora più all'estremita. E però vero che se questo difetto è da attribuirsi alla generalità, non mancano individui che offrono un vello assai uniforme, più chiuso, con bioccoli quasi prismatici e costituiti da fili molto ondulati misti a

No. d'ordine	Provenienza degli ovini esaminati	Sesso degli ovini esaminati	Età degli ovini esaminati	Regione da cui è tolto il campione	Lunghezza relativa cm. del bioccolo	Lunghezza assoluta (cm.) Minimo	Medio	Massimo	Diametro (in micromillimetri) Minimo	Medio	Massimo	Allungamento in mm. per ogni 100 mm Minimo	Medio	Massimo	Peso sopportato al limite di rottura (in grammi) Minimo	Medio	Massimo	Osservazioni sui caratteri della lana
1.	Tarhuna ...	♂	15-18 mesi	Spalla	14·0	16·9	18·3	19·2	29·96	46·08	64·20	36·66	41·42	50·00	6·0	13·0	26·0	molto untuosa.
				Fianco	12·5	13·4	16·3	19·0	29·96	46·32	59·92	23·33	37·80	53·33	7·0	13·7	31·0	,, ,,
2.	,, ...	♀	15-18 mesi	Spalla	10·5	15·0	16·0	16·9	25·68	33·62	49·92	23·33	39·71	46·66	4·0	9·0	12·0	,, ondulata.
				Fianco	11·5	13·6	15·9	18·6	27·82	41·88	62·06	30·00	38·56	46·66	6·0	14·5	31·0	—
3.	,, ...	♀	15 mesi ...	Spalla	15·5	21·0	22·5	24·3	32·10	48·61	74·90	7·33	36·03	47·66	5·0	18·0	31·5	ricca di giarra.
				Fianco	14·0	17·0	21·2	24·0	34·24	46·92	64·20	10·00	34·84	50·00	7·5	16·8	33·0	,, ,, ,,
4.	— ...	♀	adulta ...	Spalla	14·0	15·1	17·4	18·8	42·80	53·09	72·76	33·33	42·26	46·66	10·5	16·5	25·0	poco untuosa.
				Fianco	17·5	16·5	17·3	19·1	29·96	50·54	72·76	23·33	36·66	56·66	13·5	18·4	29·5	scura.
5.	Tarhuna ...	♀	4 anni ...	Spalla	18·0	23·3	24·3	25·3	40·66	56·15	72·76	3·66	18·75	40·00	5·5	16·5	34·0	untuosa e lucente.
				Fianco	16·0	21·5	23·2	25·9	38·92	55·94	68·48	30·00	41·90	56·65	13·5	22·1	41·5	,, ,,
6.	,, ...	♂	3½ anni ...	Spalla	10·5	15·0	17·8	19·5	29·96	46·36	64·20	16·66	37·61	50·00	7·5	10·7	14·5	ondulata.
				Fianco	11·5	16·0	16·7	17·5	38·52	56·91	77·04	3·66	26·80	46·66	4·0	18·6	36·5	molto grassa.
7.	Cars-Duda	♀	vecchia ...	Spalla	9·5	16·3	17·2	19·0	34·24	44·53	55·64	26·33	41·12	47·00	9·5	14·3	19·5	ondulata.
				Fianco	11·0	15·8	16·8	17·7	23·54	43·41	64·20	15·66	25·10	37·33	5·5	11·6	17·0	—
8.	Tripoli ...	♀	giovane ...	Spalla	9·5	14·5	17·1	19·5	25·68	41·05	59·92	16·66	34·75	46·66	12·0	19·0	27·5	molto ondulata.
				Fianco	10·5	14·3	15·6	17·2	21·40	33·88	51·36	30·00	42·37	53·33	4·0	7·6	18·5	ondulata.
9.	Garian ...	♂	4 anni ...	Spalla	22·0	25·5	28·2	30·7	42·80	53·50	72·76	36·66	38·56	43·33	18·0	24·5	29·5	poco untuosa.
				Fianco	19·0	21·0	24·4	27·0	25·68	40·96	64·20	30·00	38·66	40·00	5·5	11·6	20·5	ondulatiss e untuosa.
10.	Cussabat ...	♀	—	Spalla	10·5	18·2	21·0	23·0	23·54	31·32	40·66	10·00	27·14	40·00	2·0	5·5	9·0	untuosa.
				Fianco	11·0	16·8	18·6	21·0	17·12	31·69	44·94	23·66	36·37	51·00	3·5	10·0	16·5	—
11.	Tarhuna ...	♀	16 mesi ...	Spalla	15·5	20·7	23·4	25·3	32·10	42·29	70·62	30·00	38·09	46·66	8·5	15·4	20·0	untuosa e lucente.
				Fianco	16·0	20·7	22·3	24·0	29·96	39·13	53·50	8·00	31·99	43·33	7·0	17·6	23·5	lucente.
12.	,, ...	♀	3½ anni ...	Spalla	13·5	18·2	21·1	22·5	29·96	49·21	68·48	30·00	42·85	50·00	8·5	21·7	34·5	—
				Fianco	12·5	16·0	22·1	24·0	38·52	52·99	68·48	33·33	39·52	46·66	14·0	21·2	30·5	untuosa e ondulata.
13.	Cussabat ...	♂	4 anni ...	Spalla	10·5	18·0	19·9	20·7	21·40	35·46	55·64	10·00	29·99	43·33	4·0	8·8	13·5	ondulatiss e untuosa.
				Fianco	11·0	16·1	19·0	21·8	25·68	39·68	59·92	26·66	39·52	46·66	9·5	12·5	15·5	ondulata.
14.	Sciar-Sciara	♂	15 mesi ...	Spalla	13·0	18·5	21·8	24·0	34·24	50·84	59·92	30·00	38·09	43·33	15·0	22·6	32·0	untuosa e ondulata.
				Fianco	16·5	18·8	20·3	22·5	29·96	53·19	77·04	33·33	38·53	43·33	20·5	27·8	35·0	—

Note.—Dalla lunghezza si prese una misura sola (lunghezza relativa) per ogni campione. Dalla lunghezza assoluta si presero sette dati stabilendo le medie, lo stesso fecesi per l'allungamento e il peso. Le medie del diametro sono invece stabilite in base a venture dati per campione. Il diametro fu misurato alla baso, a meta dell'apicedei fili.

pochissima giarra. E per i caratteri dei singoli fili in riguardo alla lunghezza, allo spessore, all'elasticità, all'ondulazione e resistenza si può osservare la unita tabella dove sono riportati i resultati dell'esame eseguito nel Laboratorio Tecnologico dell'Istituto Agricolo Coloniale Italiano su campioni di lana presi nelle regioni della spalla e del fianco. Nell'analizzare questi valori notiamo anzitutto la poca omogeneità dei caratteri dei fili costituenti il medesimo vello e le notevoli disuguaglianze dei caratteri presentati da velli diversi. Così prendendo per prima in considerazione la lunghezza, le lane della Tripolitania possono essere comprese fra quelle che gli industriali classificano per lane lunghe o da pettine e che si usano per la fabbricazione degli articoli detti pettinati. E se per finezza la lana tripolina lascia piuttosto a desiderare, pur tuttavia, per questo carattere non è inferiore alle lane comuni della Toscana e a quelle incrociate secondarie di Buenos Aires. Molti velli però sono costituiti da fili che lungo il loro percorso presentano strozzature che facilitano lo spezzamento dei fili stessi durantela tessitura. Queste strozzature si originano durante la stagione secca per la scarsa alimentazione, e per le deficenti abbeverate, cause che provocano un'improvvisa diminuzione del diametro del filo stesso; col ritornare della buona stagione la lana riprende crescendo il diametro normale e lascia nell'ultima parte la strozzatura.

Il carattere della estensibilità è assai pronunciato nei fili esaminati; infatti questi dopo essere stati tesi, hanno presentato all'esame un allungamento di circa del 35 per cento, valore invero troppo alto, per una buona lana da tessere. L'esame della resistenza dei fili alla rottura, espresso nella tabella, in numero di grammi, ha fornito dei valori molto variabili con prevalenze di valori minimi a causa delle frequenti strozzature esistenti nei fili stessi. L'ondulazione è un carattere assai frequente dei velli della Tripolitania e se queste ondulazioni sono meno accentuate dei velli merinos, pur tuttavia superano in confronto molte delle lane comuni italiane. Le lane della Tripolitania quando sono asciutte non assorbono nè ritengono una grande quantità di acqua; da alcune prove eseguite su varii campioni, le medie ottenute si aggirano dal 10 al 15 per cento. Alcuni dei dati riferiti nella tabella allegata possono confrontarsi con quelli ottenuti dall'esame dei campioni di lana della razza incrociata Vissano-Maremmana e Bergamasca derivata, che è considerata come una buona razza da lana:

	Lunghezza assoluta mm.	Diametro micromm.	Carico di rotturo gr.	Allungamento per cento
1° Tosatura ... (medie)	119·7 Produzione di circa 1 anno compresa la agnellina	... 35·3	... 8·125	... 25·62
2° Tosatura ... (medie)	82·6 Produzione di 12 mesi	... 32·7	... 9·611	... 22·97

N.B.—Le medie sono state eseguite sopra 8 campioni, sia di 1° tosatura, sia di 2°, e per ciascun campiono sono state eseguite 10 determinazioni.

Esame di possibili miglioramenti della razza Berbera.—Uno dei più diffusi esperimenti di miglioramento della razza ovina Berbera, nell'Africa Settentrionale, è stato eseguito mediante riproduttori Merinos-Rambouillett, Soassonais e della Crau. Questi esperimenti hanno avuto luogo nel Sahel Algerino e in alcune regioni della Tunisia, molto vicine per condizioni climatiche a quelle della Tripolitania. I riproduttori Soassonais, Rambouillett, hanno fin dall'inizio dell'esperimento dimostrato la loro poca adattabilità al nuovo ambiente a causa della deficente qualità dei pascoli e delle scarse cure dei pastori indigeni. Durante questi esperimenti, si mostrarono però superiori gli ovini Soassonais a causa della loro parentela con i Lincon. I riproduttori di questa razza importati da un allevatore della Mitidya fornirono nei primi tempi soggetti di una certa precocità e resistenza; pregi che andaro però man mano a scomparire nelle successive generazioni. Alcuni Merinos della Crau tenuti perfettamente liberi nel Sahel Algerino come la razza ovina locale, e sottoposti ad eguale trattamento, produssero dei soggetti abbastanza resistenti, sobri ma che rimpiccolirono notevolmente e scemarono di peso nelle generazioni successive.

Da ciò risulta chiaramente che l'allevamento Algerino e Tunisino e di conseguenza quello Tripolino, si trova in condizioni tali che non gli permettono di stabilite la superiorità di questo o di quell'incrocio. Se il Merinos-Rambouillett infatti non ha sopportato i metodi poco razionali dell'allevamento indigeno, se il Soassonais ha manifestato nelle successive generazioni dei segni evidenti di degenerazione e se infine il Merinos della Crau ha dato resultati inferiori a quelli della razza del paese, ne consegue che il metodi dell'incrociamento debba senz'altro essere abbandonato. E a questa conclusione sono venuti quasi tutti gli allevatori dell'Algeria e della Tunisia, ad eccezione di qualche proprietario che preferisce figurare in esposizioni e concorsi senza tener conto di un giusto e vantaggioso ricavato.

Incroci Sardo-Barbareschi.—Da alcuni si è anche accennato alla possibilità di migliorare la razza berbera mediante riproduttori della razza sarda o siciliana. Ora da alcuni dati tolti dalla pubblicazione del Dott. Spissu sulla razza sarda, che per rendimento poco si discosta da quella siciliana, si rileva come la quantità di lana che essa produce non supera in media i due chilogrammi; e che riguardo alla qualità è assai mediocre e più adatta a far materasse che a fabbricar tessuti. E presumibile che la quantità e la qualità diventerebbe ancora più scadente in un paese come la Tripolitania che ha scarsezza di foraggio maggiore, per quanto poco si voglia, delle regioni di origine; e che la superiorità della razza Barberesca sia riconosciuta in Sicilia e in Sardegna, lo si desume dal fatto che riproduttori berberi sono stati importati da allevatori siciliani e sardi per migliorare le razze locali.

Selezione.—Da quanto è stato detto sui tentativi di miglioramento in Algeria e Tunisia per mezzo di riproduttori perfezionali, ne resulta che per il momento nessun incrocio si presterebbe con vantaggio alla sostituzione della razza ovina berbera, perchè questa risponde meglio di qualsiasi altra alle risorse e alle condizioni climatiche di alcuni paesi dell'Africa Settentrionale. Non Rimane quindi che esaminare il metodo della selezione, pratica che noi riteniamo più indicata ad apportare alla razza con effetto sicuro un rapido miglioramento. La selezione della razza ovina barbaresca deve avere di base sopratutto il miglioramento della produzione della lana, della carne ed in via secondaria quella del latte; e riferendoci alla prima funzione dobbiamo anzitutto tener presente che per quel che riguarda la quantità, qualsiasi miglioramento sarà possibile quando saranno migliorate le condizioni di alimentazione; lo stesso non può dirsi per quel che riguarda la qualità perchè questa, tutta si impernia sulla selezione di soggetti che forniscono i migliori velli nei riguardi dei loro caratteri fisici. Nell'esame dei campioni riferiti nella tabella allegata alcuni valori mettono in evidenza la bontà di alcuni caratteri dei velli del Cussabat e del Tarhuna; la presenza di questi vale a dimostrare come non manchino in Tripolitania animali capaci di fornire lane di buona qualità che potrebbero essere impiegate con maggior profitto nell'industria tessile piuttosto che nella confezione dei materassi. Abbiamo pure osservato come la razza Barbaresca abbia il vello sufficentemente esteso ora il metodo della selezione deve mantener costante questo carattere e possibilmente intensificarlo e ciò si può facilmente raggiungere, seguendo le norme che hanno adottate i francesi per creare nei loro Rambouillett delle vere ripiegature della pelle che hanno contribuito ad aumentare notevolmente l'estensione del vello.

Per quanto riguarda la pratica della tosatura converrà introdurre dei metodi più razionali quali le forbici appositamente costruite per i piccoli greggi, e le macchine tosatrici a mano o ad azione meccanica per i greggi numerosi. L'epoca della tosatura non dovrà esser potratta di molto tempo per non diminuire il rendimento della lana che cadrebbe in parte prima di esser raccolta. In un paese come la Tripolitania in cui l'acqua scarseggia ovunque, è consigliabile di eseguire la lavatura della lana dopo la tosatura, anche per evitare che gli animali, causa della bassa temperatura della notte vengano, dopo tosati, ad esser colpiti da pleuriti o da polmoniti. Occorre pure evitare dopo eseguita la lavatura, una essicazione troppo rapida che potrebbe esser causa di un deprezzamento della qualità della lana stessa. Perchè la selezione abbia il suo rapido conseguimento occorre inoltre che sia praticata da tutti i pastori. Cioverà notevolmente in quest'opera di persuasione l'autorità dei capi, essendo attualmente la pastorizia tutta in mano degli indigeni, e la lusinga di qualche premio in danaro da concedersi agli allevatori che esporranno i migliori capi riproduttori nelle mostre zootecniche.

L'organizzazione del Commercio della lana in Tripolitania.—Perchè alcuni mercati della Tripolitania riescano centri di qualche importanza per il commercio della lana e attirino di conseguenza un gran numero di compratori dall'Italia e dall'estero converrà in seguito limitare al minimo il numero di questi mercati per farvi accentrare la maggior parte delle lane prodotte in Tripolitania. Il sistema adottato attualmente di vendere le lana a vello intero rende impossibile da parte dell'industriale l'acquisto diretto presso i produttori; ma necessita l'opera del negoziante che tiene divise le qualità e le classifica per tipo. Così l'industriale valendosi di questo evita il pericolo di accollarsi una partita di qualità diverse di lana di cui alcune non possono occorrergli: Riteniamo che ai lamentati difetti possa in avvenire provvedere l'istituzione di una co-operativa alla quale dovrebbe confluire la maggiore quantità della lana prodotta nella Tripolitania. Un collegio peritale avrebbe poi lo speciale ufficio di esaminare le lane e di valutarle secondo la relativa resa, finezza, lunghezza, resistenza ed uso, riunendole in classi e determinadone i diversi prezzi. Questo Istituto provvedendo così alla classificazione della lana recherebbe senza dubbio un vantaggio sensibilissimo ai produttori e ai consumatori con la formazione di masse uniformi di fissa composizione e di valore determinato e favorendo così l'organizzazione di mercati stabili nei centri più importanti della Tripolitania.

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PUBLICATIONS DEVOTED TO TROPICAL AGRICULTURE AND RESEARCH.

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The present occasion of the International Congress of Tropical Agriculture would seem to afford a particularly favourable opportunity for approaching a subject of such general and widespread interest as that of the periodicals now circulating in the Tropics. It is self-evident that the geographical situation of tropical countries is such as to render inter-communication, and particularly social intercourse, matters of extreme difficulty, hence journalistic communication is very essential, and must be regarded as a matter of vital concern in the march of progress of tropical agriculture.

The sources from which periodicals circulating in the Tropics are issued may be roughly classified as follows: Trade and official (e.g., Colonial Office) publications from England and America; journals issued by Government Departments and Agricultural Societies in the Tropics; and, in a class somewhat by themselves, the summarizing publications issued by various institutions, examples of such journals being the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*, the *Experiment Station Record*, the *Review of Applied Entomology*, and the *Agricultural News*. By far the largest number of the publications at present existing come from the second source, and although in most cases these periodicals may be regarded as serving an efficient purpose in the circulation of results, there are, it is thought, certain disadvantages attaching to many of the systems at present in vogue. In the first place it must be at once evident that existing information in tropical agriculture is exceedingly scattered, and the number of periodicals —some of them merely leaflets—at present in circulation is remarkably large. This, however, cannot altogether be avoided, since many of them are intended principally for a specially limited local circulation; but there does exist a tendency on the part of every society or department that comes into existence to feel that its proper independence or status is not firmly established unless it itself published the results of its own work. In many instances this is quite unnecessary, and is frequently the cause of work which really has some general significance not being regarded as such. It is true that the large mass of published matter which is travelling from one tropical country to another is sifted in the clearing-houses of the institutions where summarizing publications are issued, but it will be seen that the want of centralization in regard to publication work, besides incurring the risk mentioned above, has a further disadvantage in that it places greater strain upon the work of these clearing-houses. As an example of the benefit that accrues from centralization, reference may be made to the work of the Imperial Department of Agriculture, which issues publications for various colonies; but even in the West Indies there is a great deal of local publication work done which might with more advantage be carried out at a central office.

Another disadvantage attendant on the circulation and storage of facts in the Tropics is the admixture of widely different kinds in the same journal. Many of the so-called agricultural journals, for instance, contain articles of both the agricultural and the scientific kind. By "scientific" is meant information that is principally of value only to specialists—for instance, entomological and mycological systematic studies. Not only does much of this literature fail to appeal to the planters, but its existence in a journal devoted to general agriculture involves a large amount of trouble on the part of the specialist, who has to hunt up references scattered through endless publications which are principally devoted to lines of work entirely different from his own.

This consideration thus leads us to realize that the want of specialization in tropical publications not only necessitates a very wide range of reading, but it also seriously interferes with convenient storage. The lack of specialization further increases the duties of librarians and those who are responsible for the provision of references on diverse subjects.

As already intimated, there are now in existence several publications of the summarizing type which assist in overcoming the difficulties pointed out in the previous paragraph, but these cannot do everything. It is impossible for any journal to abstract every article that is published, and if this be so it follows that a critical examination is necessary. Very often this is wanting in the case of summarizing journals, and good papers sometimes get neglected whilst worthless ones are placed on record. It is felt that an effort should be made in the future to confine information bearing upon each great tropical industry to specialized journals, and that the various branches of scientific work should, as far as possible, be published centrally.

In the sections of this paper which follow, an attempt has been made to outline the various media through which facts relating to the principal tropical industries obtain circulation. Perusal of this section will make it very evident how great is the overlapping amongst agricultural publications, but the notes which are given should serve a useful purpose to those who desire to know of the best publications to keep in touch with in connection with the principal industries. It may also prove useful to those who intend writing on any subject connected with the crops mentioned, since it provides a guide to the principal sources of reference.

Though it is by no means regarded as complete in this respect, the information is based on the systematic examination of publications by the writer in the preparation of articles for the *Agricultural News* (the fortnightly review of the Imperial Department of Agriculture in the West Indies), the notes are therefore the result of first-hand experience.

Rubber.

Two of the principal trade journals representing this industry are the *India Rubber Journal*, published in

London, and the *India Rubber World*, of New York. Although primarily concerned with the supply, manufacture and consumption of rubber, these periodicals do not neglect the industry from the grower's point of view, and in connection with plantation manufacture these journals are particularly worth perusal by the tropical planter. A third journal of value to the rubber grower is *Tropical Life* of London.

From the purely agricultural aspect, the most important papers on rubber growing make their appearance in the publications of the Department of Agriculture, Federated Malay States, and in those of the Department of Agriculture, Ceylon, including the Annals and Circulars of the Royal Botanic Gardens, Peradeniya. Useful information appears occasionally in the *Bulletins* of the British Guiana and Trinidad Departments of Agriculture, as well as in the *West Indian Bulletin* of the Imperial Department of Agriculture for the West Indies.

The state of the French rubber trade finds an outlet in the *Bulletin de l'Association des Planteurs de Caoutchouc*, whilst important information on rubber planting appears from time to time in the *Journal d'Agriculture Tropicale*, in *L'Agriculture Pratique des Pays Chauds*, and in that interesting and particularly well-illustrated periodical, the *Bulletin Agricole du Congo Belge*. Valuable papers concerning rubber in the German colonies are to be found in *Der Tropenpflanzer*, whilst accounts of South American work appear from time to time in the various *Bulletins* of the Latin-American Republics.

As regards official publications that devote attention to rubber which are issued from London, reference must be made to the *Bulletin of the Imperial Institute*, which is yearly becoming more indispensable and almost international in importance. As a source of reference on the technology and chemistry and economics of rubber this journal is of special value. For botanical information the *Kew Bulletin* frequently proves a fertile source of reference, whilst for trade notices and changes of legislation and production statistics the *Board of Trade Journal* should be consulted.

In concluding this section on current literature on rubber growing and manufacture, the value of the Colonial Reports, and for foreign intelligence, the Consular and Diplomatic Reports should be noted. It is necessary also to acknowledge here the international publication, the *Monthly Bulletin of Agricultural Intelligence and Plant Diseases*. As is well known, this bulletin publishes abstracts of most of the important papers that appear in connection with tropical agriculture, and is of special service in that it obviates a great deal of search and translation. The same remarks apply in a somewhat less degree to the *Experiment Station Record*. But this latter publication confines itself more to the recordance of experimental work, consequently it cannot be said that its perusal is of especial value to those immediately interested in rubber growing.

Finally, there is the Press in the Tropics and at home. *Grenier's Rubber News*, the *Ceylon Observer*, and the Demerara papers all devote space to matter pertaining to the industry. In England there is the *Times*, in which the accounts of Company meetings bring to light many new and interesting facts which are well worth the attention of those connected with the industry.

Cotton and Fibres.

There are not many periodicals devoted entirely to cotton, although there is a great deal of matter published in the form of papers and reports. In England, the Reports of the British Cotton Growing Association are of interest and value as an indication of progress, especially in Africa. The *Textile Mercury*, *Textile Institute Journal*, *Cotton* and *Cotton Gazette* of Manchester are also useful journals, and should be more widely read in the Tropics, as they help to keep the planter in closer contact with the manufacturer. As would be expected most of the important literature on cotton growing emanates from the United States, Egypt, India, West Indies, and East and West Africa. The amount of matter published by the United States Department of Agriculture on cotton is large, the extent and nature of which can be well gauged by reference to the indexes of the *Experiment Station Record*. To the West Indies the American work on cotton has been and is of inestimable value, and the same appreciation must be felt in Egypt and India. The characteristic feature of the American work —and it is shown in their publications—is the energy and ingenuity displayed in order to surmount the practical difficulties which confront the grower.

To Egypt the cotton-growing world is indebted for the *Journal of the Egyptian Department of Agriculture* and for numerous papers on the cotton plant and on the cotton seed problem published through various channels. A useful French journal is the *Bulletin de l'Association Cotonier Coloniale*. From India comes the *Agricultural Journal of India*, which from time to time contains papers on cotton, and also the *Memoirs of the Department of Agriculture in India*, and the various local Department publications. Owing to the industry being in a state of rapid development, the African literature is principally composed of progress reports. But in Africa, as in other cotton-growing countries, special problems will have to receive systematic investigation, and in the near future we may look to East and West Africa for new facts concerning the cotton crop. Technological matter, concerning East and West African cotton, appears from time to time in the *Bulletin of the Imperial Institute*. The *Indian Trade Journal* and *British East Africa Agricultural Journal* often contain valuable information on cotton.

Several of the French periodicals devote some attention to cotton, particularly the *Journal d'Agriculture Tropicale* and *L'Expansion Coloniale*. The South African attempts in the direction of cotton growing find publicity in the *Journal of the Department of Agriculture of the Union of South Africa*, whilst at home general references to the industry will be found in *Tropical Life*, and from a statistical standpoint in the *Board of Trade Journal*.

Information concerning the West Indian cotton industry is to be found in the publications of the Imperial Department of Agriculture, namely, the *West Indian Bulletin*, the *Agricultural News*, the Pamphlet Series, and in the West Indian Botanic Station Reports.

Turning to the periodicals which deal especially with fibres, reference may be made to the *Journal d'Agriculture Tropicale* and to the Philippine publications, particularly the *Philippine Agricultural Review*, which devotes much attention to the production of Manila hemp and kapok. In England, the technological and economic side of fibre production receives systematic consideration in the *Bulletin of the Imperial Institute*, and various aspects of the industry are written up from time to time in *Tropical Life*. The work in German possessions in Africa will be found described in *Der Tropenpflanzer* and in the official publication of the Amani Institute, *Der Pflanzer*. Owing to the development of fibre growing in Fiji, Mauritius, Jamaica, and the Bahamas, the Reports of the Department of Agriculture of those colonies often prove of interest. Special attention may be given to the *Bulletin Agricole*, Mauritius, and to the *Revue Agricole*, Rèunion. It is hardly necessary to add that those interested in fibre should follow closely the summarizing publications referred to in the first section of this paper. Doing so will often be the means of becoming acquainted with work in foreign countries which has been published in periodicals that have a very limited circulation.

Sugar.

The economic and manufacturing side of the sugar industry is represented in England by the *International Sugar Journal*. In America this side of the industry, as well as production, is dealt with by the *Louisiana Planter*, *Sugar*, and the *Modern Sugar Planter*. These journals also report on affairs in Cuba, though this Republic has its own organs, as exemplified by the *Cuba Magazine* and the *Cuba Review*. From Porto Rico, near by, comes the publications of the Government Experiment Station and the local Planters' Association. On the sugar industry of the British West Indies, the Imperial Department of Agriculture issues periodicals and reports, as do also the Departments in British Guiana, Trinidad, and Jamaica. From India, important papers come in the publications of the Departments already referred to under cotton, whilst the industry in Mauritius receives regular attention in the *Bulletin Agricole* and in the Departmental reports. Java and the Dutch colonies generally are represented by *Der Indische Mercuur Archief voor de Suikerindustrie in Nederlandsch-Indië*, *Bulletin van het Deli Proefstation*, and others. In the East, also, the Hawaii Agricultural Experiment Station publishes valuable bulletins on sugar production, and in Australia there is the *Journal of the Queensland Department of Agriculture*, and the *Australian Sugar Journal*, published at Melbourne. The principal sugar journal in South Africa is the Durban *Agricultural News*. Facts concerning the sugar industry in the Argentina find circulation in *Revista Industrial y Agricola de Tucuman.*

Tea and Rice.

The production of these two crops being principally confined to the Far East, one looks to publications from this part of the world for leading information. Tea and rice go into consumption without that intensive manufacture which characterizes rubber, fibres and sugar, and this lessens the necessity for the very technical journals that have arisen in connection with these latter-named crops. As regards tea, Ceylon and Southern India publish the results of work through the medium of the *Tropical Agriculturist*, *Indian Planters' Gazette*, and the *Planters' Chronicle*. The Reports of the Assam Department are also important. The Indian and Ceylon publications devote considerable space to the subject of rice growing. It is also of interest to note the appearance of papers and articles on this industry which are of late making their appearance in the British Guiana and Trinidad periodicals consequent on the settlement of a coolie population in these colonies. Hawaii, too, has a developing rice industry, and experimental work has for some time been in progress there. The Japanese, the Javanese, and the West African publications also should be consulted in regard to rice growing.

Coffee and Tobacco.

The cultivation of these crops, particularly tobacco, is very widely spread, hence literature dealing with them is scattered. For coffee, the Brazilian publications, e.g., *Boletim de Agricultura, Sao Paulo,* may be usefully consulted, also the Surinam and Jamaican and Porto Rican agricultural literature. The *Planters' Chronicle* of Southern India generally has several pages devoted to experimental work connected with coffee.

Important literature on tobacco growing is to be found in the American and Indian official publications, particularly the *Bulletin of the Ohio Experiment Station* and the *Memoirs of the Department of Agriculture in India.* Almost all the general agricultural journals referred to in previous sections contain from time to time articles on tobacco, but special reference may be made to the *Bulletin of the Imperial Institute, L'Agriculture Pratique des Pays Chauds,* and *L'Agronomie Tropicale.* Much of literature on tobacco comes from Hungary and from Salerno, in Italy. Tobacco growing in South Africa is dealt with in the *Union Agricultural Journal,* whilst the Nyasaland Reports contain interesting information concerning the industry in East Africa.

Coconuts and Bananas.

The cultivation of coconuts has received much systematic attention in the Philippines. The *Philippine Agricultural Review* and other publications issued in these islands are, therefore, important sources of reference. From the Federated Malay States also comes literature on coconut growing, and special mention may be made here of the *Bulletin of the Federated Malay States Department of Agriculture.* Coconut cultivation being an important industry in Trinidad, the *Bulletin of the Agricultural Department* in this colony and the *Journal of the Agricultural Society* frequently contain papers on coconuts. The same may be said of British Guiana. There is as well to be mentioned the *Tropical Agriculturist* (Ceylon). Articles on the position of the industry from an economic aspect are frequently seen in the *Financier* and other London papers.

As regards bananas, Jamaica, the great producing centre, issues information of a practical kind in the *Journal of the Jamaica Agricultural Society,* whilst more scientific articles appear occasionally in the Department's *Bulletin*. The Hawaii Experiment Station has of late been issuing considerable literature on bananas, as has also the Queensland Department. It may be well to record here the fact that a useful literary service has recently been rendered through the publication of two books—one, entitled "Coco-nuts: The Consols of the East," and a second, "The Banana: Its Cultivation, Distribution, and Commercial Uses." These works bring together in compact form a large amount of information which was previously very diffused.

Cacao and Citrus Fruits.

The chief cacao growing countries are Ceylon, Trinidad, Grenada, the Central American Republics, Gold Coast, and the Cameroons. It is thus natural to find that most of the literature in circulation dealing with the cultivation of this crop emanates from the Departments and Societies in these places. As with most of the other industries, the growing of cacao is not neglected by the Philippine agricultural authorities. Much of the work published in Trinidad, Grenada, and Dominica in connection with cacao has referred to sanitation and the question of manuring; more attention is now being given to vegetative propagation and selection. The German publications are the best on fermentation and allied matters. In this connection reference may be made to the useful collection of papers on this subject in a book called the "Fermentation of Cacao." This affords another demonstration of the extent to which agricultural information in the Tropics is scattered. It is of value to note here that a useful journal for information on the cacao market is the *Gordian*, published at Hamburg.

Turning to publications which devote attention to citrus fruits, it is found that they are principally those issued by the Experiment Stations in the Southern States of America, the American Genetic Association, and by the Imperial Department of Agriculture for the West Indies. The *Perfumery and Essential Oil Record* and Messrs. Schimmel's *Reports* are often valuable for information concerning citrus products. Citrus culture extends into the sub-tropics; it is consequently followed by its literature, and those interested in this culture must therefore not restrict their attention to publications in the Tropics only.

General and Scientific Literature.

It is not proposed in this paper to deal at any length with the publications of a general kind, nor with the purely scientific literature that circulate in the Tropics. Brief mention may be made, however, of the *Colonial Journal* and the *Empire Review* as examples of the former class; of the latter, *Nature*, *Science*, the *Journal of Agricultural Science*, *Science Progress*, the *Journal of Agricultural Research*, the *Annals of Botany*, the *Bulletin du Jardin Botanique*, the *Kew Bulletin*, *Annales Mycologiques*, *Bulletin Trimestriel de la Societé Mycologique de France*, *Mycologia*, *Phytopathology*, *Comptes Rendus de l'Académie des Sciences*, the *Journal of Economic Entomology*, the *Review of Applied Entomology*, the *Quarterly Journal of Applied Physiology*, the *Zeitschrift für Pflanzenkrankheiten*, and the *Bulletin of Entomological Research* are examples of scientific publications issued in Europe and America which frequently contain information indispensable for conducting research in the Tropics. As already mentioned, the greater part of the scientific work done in the Tropics appears as special bulletins or pamphlets, or else somewhat unfortunately interposed between articles of more general interest in the agricultural periodicals. If institutions of the university type with a university Press existed in the Tropics it might be possible to co-ordinate scientific literature, and so render an invaluable service to those engaged in agricultural education and research.

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