MALAYAN AGRICULTURE

HANDBOOK

COMPILED BY
THE
DEPARTMENT OF AGRICULTURE
F.M.S. AND S.S.

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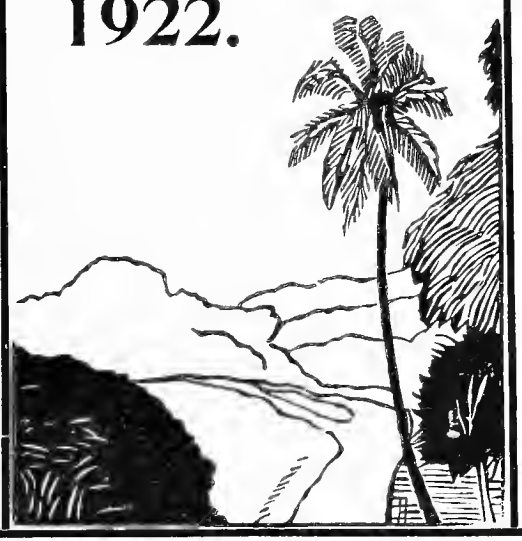

Handbook

Compiled by

The Department of Agriculture,

F. M. S. and S. S.

PREFACE.

The information contained in this Handbook has been compiled at the request of the Acting Director of Agriculture, Federated Malay States and Straits Settlements, in connection with the Agricultural Section of the Malaya-Borneo Exhibition on the occasion of the visit of His Royal Highness the Prince of Wales. K.G., to Malaya.

It is hoped that the information given will serve to stimulate active interest in many new agricultural industries which are suited to the conditions of the country The possibilities of various local manufacturing industries based on the raw products of agriculture should also be kept in view.

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MALAYAN AGRICULTURE

INTRODUCTION.

THIS handbook of Malayan Agriculture, which has been compiled by members of the staff of the Department of Agriculture, F.M.S. & S.S. is intended both to draw attention to the various agricultural products of Malaya exhibited in the Agricultural Section of the Malaya-Borneo Exhibition, with special reference to those aspects of Malayan Agriculture represented by the exhibits prepared by the Department of Agriculture to illustrate the possibilities of new crops, and to describe as concisely as possible the methods of cultivation, harvesting and preparation of the various crops for the market, the market value of the products at the present time and the possibilities of the economic, or commercial production of these crops. Chapters dealing with modern aspects of agricultural practices, which are now being applied to the cultivation of tropical products, are also included.

It is to be deplored that so little attention has been paid to the cultivation in Malaya during recent years of crops

other than rubber, coconuts and padi, and that little information is available at the present time in respect of yields, cost of planting, cultivation and preparation of various new crops.

It is not proposed however to discuss here the reasons avoidable and unavoidable for such a condition of affairs.

In the case of a large number of tropical agricultural crops however, information is available from which conclusions may be drawn as to their suitability for cultivation in Malaya, and the probable costs of production and yields estimated by a comparison of results obtained in other countries; such information has been supplied to numerous enquirers during the past year by the Department of Agriculture.

It is unfortunate also that the world-wide slump in trade and industries has, to a large extent, prevented the sinking of Capital in new agricultural enterprises. Had the present slump only or chiefly affected rubber cultivation, there is no doubt that companies and individuals would have obtained capital to embark on the cultivation of other crops.

At one time considerable interest was being taken towards reviving sugar-cane cultivation in Malaya. The large amount of capital required for the establishmen of a suitable factory and machinery, combined with general lack of capital and decrease in the market value of sugar have been no doubt largely responsible for the fact that such interest has not been sustained.

The comparative ease with which the rubber tree is cultivated in Malaya compared with the arduous nature of agricultural operations in connection with such crops as sugar or tobacco, combined with the phenomenally successful progress of the plantation rubber industry, have also a considerable influence on the problem of new crops.

It is anticipated that, as soon as world trade and industry revive, there will be ample demand for all the rubber which will be produced for many years, and most companies are banking on these anticipations. Further, many rubber companies have no additional land for the planting of other crops and, at the moment, no capital to invest in new land.

This combination of circumstances has led many individuals to think that the Department of Agriculture should

be in a position to recommend new crops which are likely to be equally successful and as easily cultivated and harvested as is rubber.

It is therefore advisable to remind those who are seeking such crops that, even as late as the year 1906, the subsequent phenomenal success of the plantation rubber industry had not been anticipated, and one has only to peruse many of the financial journals during that year to see the jibes published in connection with the floatation of many rubber companies which have since become so well-known as good dividend producers.

The success of the plantation rubber industry, unforeseen before that time, has been due largely to the remarkable increase in the use of motor transport of all kinds, due partly to the invention and improvement of the internal combustion engine, combined with the increased production of petrol fuel. In this industry, the rubber produced is consumed or destroyed fairly rapidly, and therefore further increases in motor transport appear to afford the most hopeful method for the consumption of our future supplies of rubber.

By analogy, although this is a dangerous argument beyond certain limits, the production of certain crops indicated in this handbook appears to hold out considerable prospects for the future, although at present one can only present the possibilities.

These industries are—(a) the production of alcohol for fuel purposes from various raw agricultural products containing sugars, starch or cellulose. (b) The increased cultivation of coconuts and the cultivation of new oil-yielding crops such as the African Oil Palm for the production of oils and fats for edible purposes, in view of the increasing use of vegetable fats in the preparation of margarine as a substitute for butter. (c) The cultivation of fibre plants of various kinds for cordage purposes and for supplying twine in connection with the increasing use of machinery in the harvesting of cereal crops.

In addition, there is a number of minor agricultural crops e. g. limes for the production of concentrated lime juice, citrate of lime or citric acid which are used for industrial processes in addition to their use in beverages; kapok from the silk cotton tree (*Eriodendron anfractuosum*) the commercial uses for which have increased considerably dur-

ing recent years ; tuba root (*Derris elliptica*) which is finding extended uses as an insecticide and in cattle dips etc.; various medicinal plants, including in particular cinchona ; and the castor oil plant for the production of the oil which is used as a lubricant as well as for medicinal purposes.

The cultivation of gutta-percha, for the purpose of extracting gutta from the leaves, to which reference is made in this handbook, becomes an agricultural problem as soon as this crop is cultivated on plantation lines.

It must be remembered however that most of the minor crops can be grown only on a small scale, if cultivated on many estates, since their extended cultivation on a larger scale would probably soon swamp the market. It is therefore preferable for any individual estate with large areas to cultivate more than one crop.

In connection with one of the crops mentioned above viz. Kapok, recent enquiries have shown that Australia imported during the year 1919/20 a total of 5,828,760 lbs. of a value of £319,542 and that of this total 5,703,601 lbs. valued at £312,777, were obtained from Java. This product is also imported into Malaya from Java and sold on the local market.

Enquiries have also shown that a considerable quantity of groundnuts is imported into Malaya and the oil expressed locally. The question naturally arises as to why these crops cannot be cultivated successfully on the spot, both for local use and for export to other parts of the Empire. There would appear to be two possible explanations controlling the cultivation of these crops in Java; one being the dense population of Java, which necessitates the cultivation of every possible crop as a source of revenue by the Javanese, and which necessitates also a plentiful supply of indigenous labour ; and the other being the fact that many Dutchmen in Java settle in the country and practise agriculture as they would on a farm in Europe.

Whatever be the reason, a perusal of one of the excellent yearbooks of the Netherlands East Indies will indicate the variety of crops grown in Java compared with Malaya, some of which (apart from rubber) viz. tea, cinchona, tobacco, rice, sugar and coffee are grown on a large scale.

In spite of this however, there appears to be no valid reason why, for example, a plant like the kapok tree should not be grown very extensively on small holdings all over this

country. Similar remarks apply to the cultivation of groundnuts, tuba root and a number of other crops.

It is hoped that the various chapters of this handbook, which contains concise information in respect of many crops which can be grown in Malaya, will encourage their cultivation.

It is not the object of a handbook of this character to give full details of the various cultures, but further information is being published in the bulletin issued by the Department of Agriculture, and information can always be obtained on application to the Department.

Attention is also directed to those sections in which the application of scientific principles to modern agricultural practice are discussed. The application of these principles, especially those of scientific breeding by vegetative propagation or seed selection, has already made progress and produced excellent results in Europe and America in connection with various crops e.g. wheat and other cereals, fruit culture, sugar beet cultivation, and potato cultivation. In connection with tropical agricultural products, sugar cane and cinchona especially may be mentioned as two important crops to which such methods have already been applied with success.

As is well known, similar principles are now being applied to the production of better and improved yielding strains of Hevea, chiefly by vegetative propagation, although it is yet too early to forecast the probable results, on account of our lack of knowledge of the function of latex and the influence of the application of such methods to increased latex production.

It is however imperative to test thoroughly such methods, and this can be done only by field experimentation.

The principles of seed selection have been and are being applied by the Department of Agriculture, to padi (rice) and coconut cultivation in Malaya.

The mixed character of castor seeds produced on one or two estates in the country indicates also the necessity for applying similar principles to this crop, and there is little doubt that good results will be obtained by the application of similar methods to a large number of other crops.

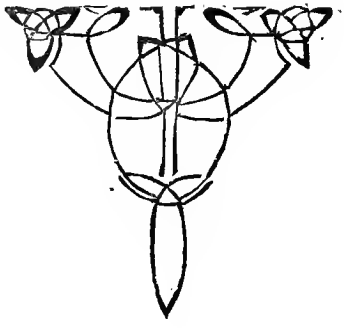
Recent work on the vegetative propagation of lemons in California, in respect of both yields and character of fruit,

has had marked results and investigations of this character will have to be applied in this country. Further, the introduction and cultivation of new crops will necessitate increased investigations in connection with the important problems of pests and diseases, and there is already ample indication of the activities of various pests and diseases on a few crops which have been tried during the last year or two. In this connection, there is need for a broader outlook on this important problem. Recent investigations in India have indicated the close connection between the question of pests and diseases of plants and problems of plant physiology, and the effect of soil and soil water problems on the incidence and spread of pests and diseases.

Finally, in the cultivation of many crops, especially annual crops and other crops in which a large amount of plant food is removed from the soil, problems of soil fertility and the application of manures, conservation of soil moisture, drainage, soil conservation on hilly or undulating land, the use of leguminous and other cover crops and the use of machinery for cultivation, require far more consideration than in the case of the cultivation of the rubber tree.

In addition to the probable and possible new agricultural industries briefly discussed in this handbook, there are sections dealing with one or two industries, which although outside the range of agriculture, are of importance and are being investigated by the staff of the Department.

The two most important are the possible production of paper pulp from various indigenous raw materials and the utilization of peat.



Agricultural Practice in Malaya.

Soil Conservation and Cultivation.

Review of Crops.

Native Agriculture.

CHAPTER I.

Agricultural Practice in Malaya.

THE history of Malayan Agriculture is associated with the introduction of Hevea, and it is due to the remarkable success of rubber cultivation that other possible crops have been neglected. An idea of the importance of Hevea relative to other cultivations may be obtained by comparison of the Agricultural Acreages in the Federated Malay States for the year 1920.

Rubber	779,170 acres.
Coconuts	72,149 ,,
Padi	197,000 ,,
Coffee	2,364 ,,
Other crops	6,112 ,,

Cultivators in this country were not slow to appreciate the comparative ease of obtaining a handsome return by planting Hevea. Unfortunately, in the haste to establish plantations, too little attention was given in many cases to matters affecting the health of the trees and conservation of the soil. This has resulted in a considerable amount of

disease and many badly grown trees in our plantations, especially on native holdings. At the present time, however, more thought is being given to problems affecting the permanency of rubber plantations and such matters as judicious thinning, sanitation and soil conservation are receiving a considerable amount of attention. A welcome sign is the amount of interest being taken in the attempts to establish improved strains of Hevea. These matters are dealt with individually in subsequent chapters in this Handbook.

Cultivation and Soil Conservation : In the cultivation of rubber and coconuts the minimum amount of cultivation is, as a rule, given. Recent experiments in Sumatra have shown that the cultivation of soils of rubber estates over seven years old is without effect on the yield and has no apparent effect on the growth of the trees. Motor tractors are being introduced on coconut estates where the conditions are frequently such as will permit of their adoption.

The hilly and undulating land of the Peninsula is subject to considerable surface wash after having been cleared of jungle, and it is now realised that it is necessary to prevent this. The surface layer is rich in humus and available plant food, consequently denudation is responsible for a reduction in fertility and a deterioration of the texture of the soil. It is doubtful whether green manuring and the application of artificial manures will ever compensate for this loss of surface soil by wash, and in any case, the expenditure involved in attempting to restore this fertility is heavy. There are several methods of conserving surface soil, the more common being the establishing of cover crops or strong-growing grasses in contour, strip-weeding, circle weeding, catchment pits, terracing and bunding. The application of one or more of these methods is now becoming important in agricultural practice in Malaya.

There is room for improvement in native agriculture both in respect of the methods employed and the variety of crops cultivated. This subject is fully discussed in the latter part of this chapter.

Review of Crops: The relative importance of rubber and coconuts has already received notice. Coffee, once a crop of some importance, now occupies a comparatively small area as a secondary crop with rubber. There are considerable tracts of land suitable for coffee cultivation but it is improbable that coffee would be a financial success unless interplanted with other forms of cultivation.

Sugar was at one time cultivated in the Peninsula, principally in Province Wellesley and Lower Perak, but it is now only grown by the small holder for the local market. A number of improved varieties of sugar are now under trial by the Department of Agriculture. It is unlikely, however, that sugar will receive much attention as a planting proposition for the present, owing to shortage of labour.

The African Oil Palm is receiving attention and is remarkably well suited to Malayan conditions. It is probable that this crop will occupy, in the near future, an important position in the agriculture of the Peninsula.

The cultivation of tea has recently been the subject of some interest and an estate in Pahang consisting of 600 acres is being opened up. There is little doubt that tea may be grown with success in Malaya, and provided suitable labour is available and a market can be found for the produce, it should prove a sound undertaking.

There is room for development in the cultivation of oil yielding plants in the country. In addition to coconuts and the African oil palm there are others which may be grown with success. Castor, gingelly and ground nuts are examples.

The Malay Peninsula was at one time the principal spice growing country in the East Indies and large quantities of pepper, cloves and nutmegs were exported annually. This industry has dwindled down until it is now of little importance. The spices that are produced command good prices. The experimental cultivation of these crops on a commercial scale is now being undertaken by the Department of Agriculture.

Tapioca, which was formerly grown on a considerable scale is still cultivated, though to a less extent, in Negri Sembilan, Pahang and Johore.

The cultivation of fibre plants has created a considerable amount of interest recently, and many enquiries have been received by the Department of Agriculture regarding numerous species. Those of chief interest are Manila, Sisal, Mauritius and Bowstring Hemp and Roselle Fibre. Several of these crops have already been planted on a commercial scale.

Native Agriculture: Agriculture, other than the cultivation of rubber, coconuts and padi, as carried on in this country, consist of "Mixed farming," It is almost entirely in the hands of the Chinese and Malays. Near all large centres of population are found Chinese market gardeners who supply the local markets with vegetables, and in some cases send their produce to the larger towns in the Peninsula. Such cultivation is conducted under Chinese methods, which carry with them obvious objections. The Chinese have also been the pioneers in numerous other crops; tapioca, pineapples and formerly gambier and pepper are the more important of these. Tapioca is less cultivated than was the case a few years back, owing to the fact that the land has been "worked out," and in most cases, has since been planted with rubber. Pineapple canning—a Chinese industry in Singapore—has diminished, for the canners find difficulty in obtaining sufficient pineapples to keep their factories working. Cultivators on the other hand, are less inclined to plant pineapples, as they impoverish the soil. There has however been a revival recently in this cultivation.

The efforts of the Chinese to establish fruit industries is worthy of note. There are now several good fruit orchards, owned by Chinese, principally in Malacca and Penang, from which markets are regularly supplied.

The Malays lack the organizing power of the Chinese, and also their industry. The competition for life has never been keen with them, as with the Chinese in China, and this is reflected in their agricultural systems. Generally speaking, one may state that Malay agriculture lacks effort, and the systems are devised without respect to the amount of labour involved. This is surprising in an easy-going race, but the reason probably is that their wants have been so simple that the work involved in supplying necessities is comparatively small. It must be remembered that, until recent years, the Malay obtained the majority of his necessities from the jungle, and his mentality has, as yet, hardly grasped the new order of life. As time goes on, Malay life recedes from the jungle, and with the diminishing knowledge of jungle produce which follows, he has to rely more on cultivated plants.

The gradual transition from this old order to the new was rudely interrupted by the introduction of rubber into Malaya. In this crop the Malay saw that he might earn sufficient to supply his wants without much effort.

effort. The consequence has been that agricultural enterprise amongst Malays has been practically killed—he has lost his old cunning without acquiring new experiences in agriculture.

New systems have to be introduced to change this order of things. Comparatively little can be done with old Malays of set habits of life, but much is possible with the younger generation. It is for this reason that the Department of Agriculture has advocated a system of agricultural education (really rural economy) for Vernacular schools.

To deal with present day "Native agriculture" as it applies in particular to Malays, nothing can be done without encouragement and one can call to mind many industries that are suitable for Malay adoption, but only so far as they are encouraged in the correct way. For the introduction of an agricultural industry amongst natives there are two essential conditions—firstly, instruction in cultivation and marketing; and secondly, financial aid. The matter of instruction is in the hands of the Agricultural Department, and that of organization of small industries must be dealt with by the recently created Government Co-operative Department. In the publications of these two bodies will be found the suggestions for the improvement of native agriculture.

The following agricultural industries suitable for Malays and other Asiatic owners of small holdings may be mentioned.

Padi :—This cultivation, under existing conditions, is more suitable for small holders than for planters on a large scale. The main difficulty has been water control and cost of labour. Padi yields, outside the Krian area, are generally poor, and until the Malay is supplied with better types of seed, and can be more sure of a regular water supply, there is not likely to be any increase of area planted under this crop.

Fruits :—Apart from a few imported fruits, and the supplies obtained from Chinese-owned orchards, the local market supplies of fruit are obtained from Malay "Kampongs." There is obvious scope for larger areas than those which exist, for the local demand exceeds the supply. With the introduction of larger areas must come better cultivation, if small orchards are to be carried on at a profit. The quality of most of the Malayan fruits is poor, and it is notorious that many of these fruits are but jungle trees. The Government have in hand schemes for the supply of good fruit stock to

Malays, but owing to slow maturity of fruit trees, the progress of such work must be gradual.

Tobacco :—The Department of Agriculture has carried out experiments on tobacco cultivation, and the conclusion has been reached that the production of this crop by natives is possible on average good soil. Tobacco used by natives in this country is uncured. The green leaf is cut into shreds, and dried, and is then ready for smoking. Under these conditions, the production of tobacco is simple. There is a considerable demand for this type of tobacco in Malaya and the adjacent countries, and thus, it would be wiser to fill this demand rather than to encourage amongst Malays, the cultivation and curing of tobacco for the European market. It must be remembered that locally grown tobacco is protected by Government, as it is not liable to the import duty on tobacco.

Roselle Fibre :—The Department of Agriculture has recently published much information on this crop, and Mr. Mathieu, Superintendent, Government Plantations, Kuala Kangsar has published a pamphlet on the subject. The salient facts are that roselle is simple of cultivation, the production of the fibre does not involve the purchase of any machinery, and there is likely to be a good market for the produce.

Several Chinese have commenced the cultivation of this crop, and one hears of at least one Chinese who has exported his first crop ; but the Malays are unaware of its possibilities or cultivation. For cultivation on a small scale, such as would be attempted by Malays, some system of local collection and purchase appears to be desirable ; in addition to which instruction on the crop is essential.

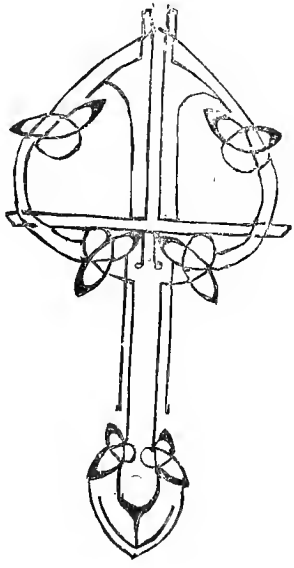
Kapok (Kabu Kabu):—This is grown by Malays generally throughout the country, but in very small quantities. If the facts concerning the market were better known, and the collection organized, the cultivation of this crop might be extended.The Department is giving serious consideration to these aspects of the problem.

Amongst the multitude of minor crops grown by natives, and on which advancement is possible, might be mentioned tuba (used as an insecticide), coconuts, coffee, chillies, areca nuts and other spices. No account, however brief, of potential native agricultural industries would be complete without mention of live stock. The excess of imports over exports

into the Peninsula, of cattle, goats, sheep and swine in one month (November, 1921) was valued at $321,228. Although it may not be possible to supply the whole of this excess from local productions, there is undoubtedly an opening here for greater local production, even under present conditions.

The figures for poultry and eggs are perhaps even more significant. The excess of imports over exports for the same period was valued at $41,969 for poultry, and $26,371 for eggs, fresh and salted. These figures speak for themselves.

The Malay homestead has been made familiar to us by its straying hens, but the production of hens and eggs as an industry is practically untouched. The Malay, and to some extent, the Chinese fowl is neglected. It is underfed, badly housed, and poor in quality. Consequently disease amongst poultry is rife and the native obtains but a small return from this source. The few poultry farms that exist, and the Klang Poultry Club, have proved that the rearing of good poultry in this country is possible and profitable. There is therefore an opening for the raising of poultry in this country under careful control; the above figures are sufficient evidence that the problem of finding a market does not exist.



Cereals.

Cultivation.

Production.

Padi and Minor Cereals.

Methods of Improvement.

CHAPTER II.

Cereals.

The importance of cereals as the most valuable of economic crops has been recognised from the earliest times. We read of their cultivation more than 4,000 years ago, and of their significance in the rise and fall of Empires right down to modern times. Neither public works nor industrial pursuits of any kind can be carried on without ample supplies of the "staff of life" for our toiling masses. The problem of our local food-production has occupied the attention of Government particularly during the years 1917 and 1918, when attention was directed to the inevitable restriction on the importation of foodstuffs into this country due to the war and the consequent lack of shipping. The increased production of locally-grown food then became a necessity, and comparatively large areas were temporarily put under cultivation. During this period the Department of Agriculture had an opportunity of enquiring into the possibilities of growing a number of food-crops which were previously unknown in this country. The results obtained were very variable, the poor returns being frequently due to unsuitable soil and lack of knowledge regarding the special requirements of each particular crop.

Our dependance upon imported supplies is evident from the fact that, though rice is the chief cereal crop of this country, we produce only approximately two-fifths of our annual consumption. This is an undesirable state of affairs, as will be acknowledged by all who experienced the rice shortage which was felt so acutely a few years ago; it is consequently one of the prime duties of Government to encourage the local production of rice; much is accomplished in a quiet way through District Officers, whose influence is always beneficial, and through the Department of Agriculture.

Selection of Land: The selection of land for the cultivation of cereals is of primary importance; any attempt to grow such crops on most of the laterite hills which are common in the inland districts, or on the poorer class of sandy soils, or on soils which have suffered from wash, is doomed to failure. The flat coastal districts, if the soil is rich, friable, and well-drained, and the lighter type of clays are as a rule suitable; but heavy clays are objectionable. Gently undulating land of good quality, with a rich soil, can be recommended with assurance.

Sufficient tillage is seldom given, owing chiefly to the lack of suitable implements for the preparation of the land. Satisfactory yields cannot be expected without a thorough preparation of the soil, particularly of the top six inches, which must be brought to a fine tilth.

Time of Planting: Sufficient attention is not usually given to the time of planting, a factor of as much importance as either quality of soil or tillage. The seasons are roughly as follows, but they are subject to considerable variations:—

(1) A long wet season, commencing in September, with the culminating point in November, and terminating in January.

(2) A short dry season, commencing in January, and comparatively dry during February and March.

(3) A short wet season, commencing in March, culminating in April and ending in May.

(4) A long dry season, commencing in May, with its culminating point in July, and finishing in September.

Planting should be done at such a time as will permit of harvesting during a dry period.

Improvement: Malaya is well adapted to the growing of wet land rice, which is the chief cereal crop, and there is no apparent reason why, in time, this country should not be self-supporting. Large reserve areas exist, which could, given the requisite labour, be brought under padi cultivation. The crops themselves can be improved, much useful work in this direction having been done by the Department of Agriculture by selecting varieties of high yielding capacity.

The idea of improving cereal crops seems to have originated during the first decade of the last century, though it was not until the last decade of the same century that any real progress was made. Improvement of grain-crops can be effected in five ways :—

(1) Pure line selection.

(2) Hybridization.

(3) Mutation.

(4) Importation.

(5) Amelioration of environment.

Pure Line Selection : Pure line selection is by far the most important method of crop improvement and has developed along two lines, the one which may be said to have begun with the English breeder le Couteur, though this breeder was perhaps unaware of the extreme importance of his method, which may be described as that of "individual plant selection," and the other known as "mass selection" being developed by several European breeders at about the same time. The latter method largely led up to the doctrine of evolution as propounded by Darwin, whose theory was that new species could be created by continued selection of individual variations. Later, de Vries' work on the nature of variation disclosed the imperfections in the scientific basis of this theory, so that it became less important; and the former method started by le Couteur and independently discovered by Nilsson and elaborated in detail by the work of Johansson and Hays, now holds the field.

Colonel le Couteur, a wheat breeder of Jersey, was

visited about 1810 by la Gasca of Madrid who pointed out that his wheat cultures, though appearing of general uniformity, were of mixed nature and really consisted of a number of distinct sorts growing together. Le Couteur saved seed separately from individuals of the different sorts and tested the progeny of each. He found that the offspring came pure to the type of the parent, each to each, and almost by instinct he did not seek to improve them further.

Similarly Sherrif, working on similar lines isolated the rare and exceptional plants in his cultures and sowing their seed separately, compared their progenies. He became eminently successful in isolating, multiplying and distributing heavy yielding types of wheat and oats. Though in his original experiments he took only the very exceptional plants for his cultures (and these were not easily discovered), he subsequently followed le Couteur's method of selecting a large number of types showing small differences and deciding on their utility by a comparison of their progenies.

This method has stood the test of time and the strong competition of the continental school, who considered that the English breeders were resting content with what nature had provided them, not availing themselves of the possibilities of continuous selection in the actual production of types theoretically conceived. The almost complete failure of the continental school and the complete vindication of the methods of the early English breeders form an extremely important chapter in the history of plant breeding.

The pure line method was independently discovered by Nilsson in 1892. Working at Svalof in Sweden he found that the number of failures that had to be recorded in the attempt at the productions of types of preconceived form by the process of continuous selection was enormous, but in that year he stated "I had occasion to observe here and there novel autumn wheats which at once opened interesting perspectives to me; they represented only 5 per cent of the whole collection. They showed uniformity and characteristic type such as we had never previously found in our plantings." These proved to be the productions of seed saved separately from individual plants. Since that discovery a colossal amount of experimentation has been executed and the results have been subjected to the most critical scientific analysis and from them the following points emerge, which direct the methods of modern plant breeding.

Ordinary varieties of plants are built of many elementary forms. These forms may be distinguished by botanical or agricultural differences or they may be of such a nature as to present neither of these distinguishing features, their differences being of a physiological nature ultimately distinguishable by chemical analysis. They have to be selected once, and then if the original selection is not of hybrid nature their constancy is assured as long as contamination is provided against.

Thus, modern plant breeding is rather of the nature of the isolation of the elementary species already present than of the creation of new species.

This method of plant improvement has been applied to rice in the Krian district of Perak where there is a continuous area of some 56,000 acres of irrigated rice land of which roughly 52,500 acres are planted annually with wet rice. This being the largest and most important rice producing area in the Federation, the attention of the Department of Agriculture was turned early towards it as being the most promising of improvement.

This district produces annually an average of thirteen million gantangs of clean unhusked rice (padi), so that every 10 per cent increase in production would mean over one and a quarter million gantangs of unhusked rice, or sufficient to feed over ten thousand persons for a year.

An examination of the standing crop in this district showed clearly that each of the chief varieties of wet rice was made up of a number of types differing in height, in robustness, in tillering, in yielding capacity, etc. A normal crop of a specified variety will yield on the average a certain weight of rice, but from such a crop it is possible, by selecting individual plants or preferably single ears, and by growing their progeny separately, to isolate a number of types or strains, each of which bears some distinctive character or characters. Some of these characters will be physiological, that is, will be indicated by the nature of response to environment. If such an isolation of strains is effected and the grain of each strain is multiplied separately until there is enough to sow one acre of each, the yields of each will not equal the average for the variety. Some will give more and some will give less than the average in such a manner that the sum of all the yields divided by their total number will equal the average for the variety. Clearly a direct and immediate increase of yield

will be the result of such a selection, if in future years, only the highest yielding strains are used for seed purposes ; but it is also clear that the wider the selection of strains the more likelihood there is of obtaining high results.

During the harvest 1916-1917, 300 strains of padi were selected from the heaviest producing areas in Krian and grown as pure lines. At the following harvest 1,000 more selections were added to these, making a total of 1,300 strains, which were planted out as pure lines in triplicate for two successive seasons, before any elimination of the poorer ones could be made, owing to bad weather conditions and the great influenza epidemic which affected the cultivation of the crop very adversely in 1918. In each season since that date, approximately half the number of strains under trial have been discarded, so that in the present season only 120 strains, representing five varieties, are under trial. The mean yielding capacity of these 120 strains, is 26 per cent higher than the average yield obtained from unselected seed.

Each of these strains has been planted out in quadruplicate plots, and after data respecting their comparative yields have been collected, the number of strains will probably be reduced to about thirty. Thus, this practical application of pure line breeding with rice is already well on the way to prove the utility of the method.

Hybridization: Hybrid plants result from cross fertilization between different strains of the same variety or between different varieties. The laws which govern hybridization were first investigated by a monk named Mendel in 1865 although the value of his work was only appreciated in 1900, when the problems which it solved became known as "Mendelism."

If a plant it regarded as being built up of a number of factors, each of which behaved as a separate and individual unit and each of which is transmitted as a unit from parent to offspring, then it is easy to understand that a hybrid is a new combination of the factors existing inherently in the parents which produced it. Thus a hybrid may differ from either or both of its parents in morphological or physiological characters or in both respects, but it is almost always possible to reproduce the parents of a hybrid by self-fertilizing it and separating out the progeny systematically.

The hybridization method of improving cereals is impor-

tant when it is required to combine in one strain, two or more desirable characters such as heavy yield and early maturity; preliminary work on these lines is already in progress with rice.

To be successful, hybridization must follow pure line selection so that the practical values of the crossed varieties may be fully known. Crosses should always be made with a definite purpose of combination, care being taken to avoid crossing sorts which are too dissimilar in character. After artificial crossing, pure line selection must be applied rigidly again in order to pick out the different resulting types and to purify them.

Mutation :—In his study of the subject, de Vries showed that, as is now generally accepted by biologists, variations are of two kinds, (a) fluctuating variations, which are due entirely to environmental influence and are not heritable and (b) discontinuous variations which arise unexpectedly and are due to sudden and unexplainable changes in the germinal substance of an organism. These latter variations, which are of infrequent occurrence, but are always transmittable, are mutations. Mutations are not due to any recognisable stimulus ; nor can they be controlled but appear fortuitously, and if they show any particularly desirable characters they have only to be maintained and developed as pure lines, in order to make that desirable character permanent.

Nevertheless, simple as this method of finding new races may seem, it is not favoured by breeders because, on the average, mutations do not appear to be of a progressive nature, indeed the records of the chief cereal breeding station in Europe now seem to indicate that all mutations are retrogressive and that only characters formerly in existence arise in this manner, probably as the result of previous natural crossing in remote generations. If this is correct, it is of little importance to spend time in seeking for things which can be produced artificially and with much greater assurance of obtaining an advance.

Importations: It sometimes happens that the variety of a cereal used in a district is found to yield unsatisfactorily and that seed imported from some other district or country, where environmental conditions are somewhat similar, shows a distinct improvement.

This has been proved with rice in the Federated Malay States, for Krian seed has given marked success in several districts and in some cases, it certainly

threatens to supersede the varieties grown previously. Importations may frequently show no immediate signs of success but, since all plants possess to some extent an inherent power of adapting themselves to their environment, they may in time become acclimatized and then prove better than the local types. Thus, a Japanese variety of rice which took seven years to become acclimatized to conditions in Italy now supersedes all other varieties on 250,000 acres in that country.

However, improvement of already acclimatized types is usually the better method to adopt.

Amelioration of environment: All cereal crops respond readily to improved methods of tillage or to any improved condition of the soil such as would be derived by the addition of manure. The fact that crops will grow at all depends on the law of the minimum, which demands that certain minimum amounts of nutrient substances shall be contained in the soil. For each crop there is an optimum condition of amelioration; for too luxurious conditions tend to develop vegetative growth at the expense of yield of grain, which is almost always the main object in growing cereals, but as far as local crops are concerned, there is little fear of over cultivating the soil. The growing of green manures, with subsequent ploughing in of the organic matter, would seem to offer most promise with rice in this country, but satisfactory water control is first of all necessary, before this can be done satisfactorily.

In conclusion, while the scope of the plant breeder in the direction of the improvement of cereals is great, it must be recognised that it is work that is not simple, but which requires training, experience and application if success is to be achieved, for many difficult problems arise, such as methods for testing strains etc., in the course of experimental work, which only scientific training can solve. Further as will be evident from the above, such work is comparatively slow.

Cereal Crops: *Wet land padi.* It has been pointed out that wet land padi is the chief cereal grown in this country, and a short account of the work that is being done to improve the yield etc. has been given above. When a sufficient stock of selected seed is available for distribution, we shall have gone a long way towards stimulating interest in rice-growing, and in encouraging the cultivation of large areas with this crop.

YOUNG CINNAMON TREES ON TERRACED LAND
at Kuala Lumpur Experimental Plantation.

Canavalia ensiformis, AS A GREEN MANURE

Dry land padi. Dry land padi is grown under conditions similar to those required for other cereals. It is customary with the Malay to harvest one or two crops of dry land rice on newly opened jungle before placing the land under other crops. Dry land rice is occasionally grown as a catch-crop in young rubber and coconut clearings. The cultivation required for the growing of the catch crop and the subsequent turning under of the stubble would compensate for any loss caused by the removal of the crop, but it would be unwise to continue this practice as the permanent crop would in all probability be adversely affected.

Maize.—Maize comes next in importance as a cereal in the Malay Peninsula and although there is no single area of any size, yet, the aggregate of all the small plots comprises a comparatively large area and its cultivation is on the increase. The cultivation of maize in Java has been extended considerably and has now become an article of export.

The Tamil coolie does not appear to relish it in quantity but it is a common partial diet. Malays and Javanese favour this cereal and it is frequently grown where such labour is employed. There are numerous varieties and it is important that thorough trials be made to ascertain which is the best variety for local cultivation. Maize requires moderately rich soil and appears to thrive best on land recently brought under cultivation which has a good proportion of humus and is of a friable nature. Poor soils, stiff clays and sour lands are undesirable. The yield varies from 100 to 200 gantangs per acre but with intensive cultivation on alluvial soil this may be increased by 50 per cent. The cost of production is from $35 to $34 per acre.

Ragi.—Ragi *(Eleusine coracana)* comes third in importance but is of relatively small account as compared with rice or maize. It is an important food crop in India where there are from 5½ to 6½ million acres. It is perhaps the most productive of the Indian cereals. It is unlikely that Ragi will ever form a sole diet for imported Indian labour, but it is much relished in small quantities. This cereal will grow on most soils other than laterite and is well suited to Malayan conditions. The crop matures from three to four months after transplanting. With good cultivation 200 gantangs per acre, per crop, is a conservative estimate. The cost of production varies from $30 to $40 per acre.

Millets :—Italian, Bulrush, Common, Kodo and Little

Millet can all be grown locally but the grain is particularly liable to be attacked by rice birds in the field, consequently much grain is likely to be lost unless large areas are under cultivation. Bulrush, Common and Little Millet are crops of three and a half months' duration, the first yielding about 200 gantangs per crop, per acre and the other two 100 gantang each. Italian Millet is a three months' crop, yielding about 100 gantangs and Kodo millet four and a half months', with a similar return. Bulrush millet is cultivated extensively in many parts of India and, where grown, forms the staple food of the people. This cereal is readily eaten, when obtainable, by the Tamil coolie in this country. When the ravages by birds are overcome it seems probable that "Kambu" will take second place to or even equal "Ragi" as a food crop for Tamil labour.

Sorghum :—Sorghum is an important cereal but the Tamil coolie appears to regard this grain with less favour than Ragi, Bulrush or Italian millet, Sorghum is an exhaustive crop and should not be grown on the same land for two consecutive seasons. It will grow on the majority of soils in this country but requires deep cultivation to give heavy yields, it responds well to the application of manures, particularly cattle manure. The crop is ready to cut in the fifth month after sowing. On ordinary land a yield of 150 gantangs may be obtained but yields varying from 200 to 250 gantangs are produced on fertile land with good cultivation. Cost of production $35 per crop, per acre.

Jobs Tears :—Jobs Tears (*Coix Lacryma-jobi*) is sparingly grown by Malays but it is frequently cultivated by the "Sakai" tribes who grow it to replace rice. The grains of the cultivated forms are sweet and wholesome, and are milled into flour. Under cultivation the grain becomes soft shelled and usually lighter in colour though sometimes remaining deep blue or black. The plant met with in Malaya does not appear to have undergone much improvement. The grain matures in the third month from sowing and harvesting continues for several weeks. This crop appears well suited for cultivation in Malaya, but as to whether the grain is likely to find favour with the Tamil labour force is a matter for investigation.

Fruit.

Fruit Growing as an Industry.

Minor Fruits.

Pineapples.

Bananas.

Limes.

CHAPTER III.

Fruit.

WITH the exception of the pineapple and the lime, no fruits are cultivated in the Peninsula on a scale approaching an industry. Bananas, mangosteens, rambutans, durians, papayas and several other fruits are grown in the vicinity of the towns and brought into the market for sale. There is a considerable demand for good fruit and frequently the supply is insufficient to meet local requirements. It is a difficult matter to instil into the mind of Asiatic growers that by the sale of a first class product a regular market and higher price is obtained.

There appears to be a market for certain fruits in Australia provided that shipping facilities would permit of the rapid and cheap transit of the fruit to markets. Taking into consideration the high cost of labour in Australia, it seems quite possible that fruits such as the banana and mangosteen might be placed on the markets of that country with a fair margin of profit to the grower in this country. Enterprise is needed in Malaya to compete with Java in the supply of minor products to Australian markets.

Many fruits are admirably suited for jam making but the practice of making preserves is rarely undertaken in the Peninsula. The guava, papaya, pitangi, roselle and carambola are all excellent fruits for making into jam. There is room for improvement in this respect both as regards the cultivation of fruit by Europeans for home production of jams and the manufacture of jams by Asiatics for export.

The majority of European compounds contain few fruit trees, while on estates it is quite unsual to meet with fruit trees in any quantity. This state of affairs must be partly attributed to the fact that many such gardens are newly established or again through frequent change of the occupier have had little chance of becoming planted. Obviously the mere planting of fruit trees insufficient. The trees require periodical attention, and a little time and trouble expended in their care will be amply rewarded by increased growth and a larger crop of fruit.

The following list includes the principal fruits for various purposes :—

Dessert Fruits :—

Chiku	*Achras sapota*
Coconut	*Cocos nucifera*
Duku	*Lansium domesticum var duku*
Mangosteen	*Garcinia Mangostana*
Papaya	*Carica Papaya*
Pineapple	*Ananas sativus*
Plantain	*Musa* spp.
Pomelo	*Citrus decumana*
Pulasan	*Nephelium mutabile*
Rambutan	*Nephelium lappaceum*
Sugar-apple	*Anona squamosa*

Fruits for Stewing and Preserves :—

Belimbing	*Averrhoa belimbi*
Carambola	*Averrhoa carambola*
Carounda	*Carissa Carandas*
Guava	*Psidium guajava*
Papaya	*Carica Papaya*
Pineapple	*Ananas sativus*
Pitangi	*Eugenia uniflora*
Roselle	*Hibiscus Sabdariffa*
Rumeniya	*Bouea microphylla*

Fruits for Making Cooling Drinks :—

Buah susu	*Passiflora laurifolia*
Lime	*Citrus acida*
Orange	*Citrus Aurantium*
Roselle	*Hibiscus Sabdariffa*
Soursop	*Anona muricata*

The Department of Agriculture has published an illustrated bulletin 'Fruit Culture in Malaya' (No. 29, issued 1919), containing descriptions and full cultural directions for all fruits suitable for cultivation in the Peninsula. It is unnecessary here to recapitulate the information regarding these fruits.

A great difficulty is experienced in obtaining young fruit trees. A large number of seedlings are raised on the Experimental Plantations for distribution but the supply is rarely equal to the demand. There is a distinct opening for smallholders to raise good-quality fruit trees for sale. Certain fruits should be propagated vegetatively, and there remains much work to be done to throw more light on this subject. Other fruits may be raised from seed, and it is a matter of no great difficulty in many districts to obtain supplies of seed during the fruiting season. The seeds of a number of fruits deteriorate rapidly and will only germinate if sown within a short time after maturity.

There appears to be a possibility of growing several fruits on the drier hills of the Peninsula. It is improbable however that any of the mountains in Malaya are sufficiently high to grow to any degree of perfection the temperate fruits that are cultivated in the mountainous districts in India. The hill raspberries that grow in such profusion on Fraser's Hill, Pahang, and elsewhere, are quite fair eating, and with good cultivation should prove a useful addition for stewing. It seems possible that these raspberries might be improved by hybridisation. During 1921, the Brazil nut fruited at Kuala Lumpur Experimental Plantation and there appears to be no reason why this fine tree should not be a valuable addition to the fruits of Malaya.

The improvement of Malayan fruits by the application of modern methods and the introduction of improved strains from other sources are problems that require attention.

Pineapples (*Ananas Sativus*).

The pineapple is a native of Tropical America but has been introduced into all tropical countries and is extensively grown in South America, West Indies, Cuba, Hawaiian Islands, Malay Archipelago and Queensland.

In the Malay Peninsula the pineapple is grown both for dessert and canning purposes and the largest planted areas are to be found in the Island of Singapore, where there are several large canneries engaged in the preserving of the fruit. The local industry is very large, as will be seen from the following figures, which show the exports from Singapore for the last two years.

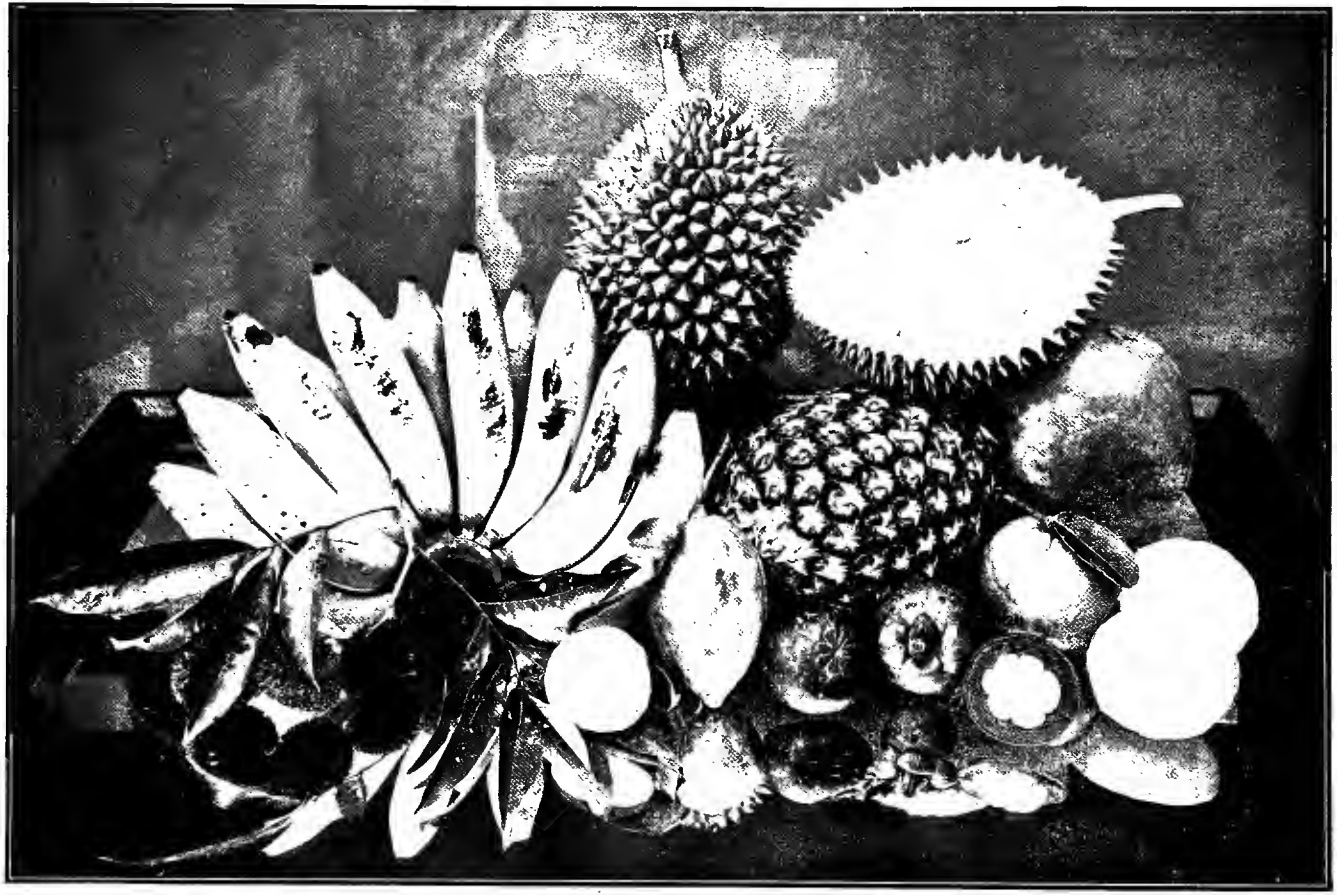
	Quantities. Piculs.	*Value.* $
Exports, 1919 ...	255,813	3,286,001
„ 1920 ...	446,890	7,177,976

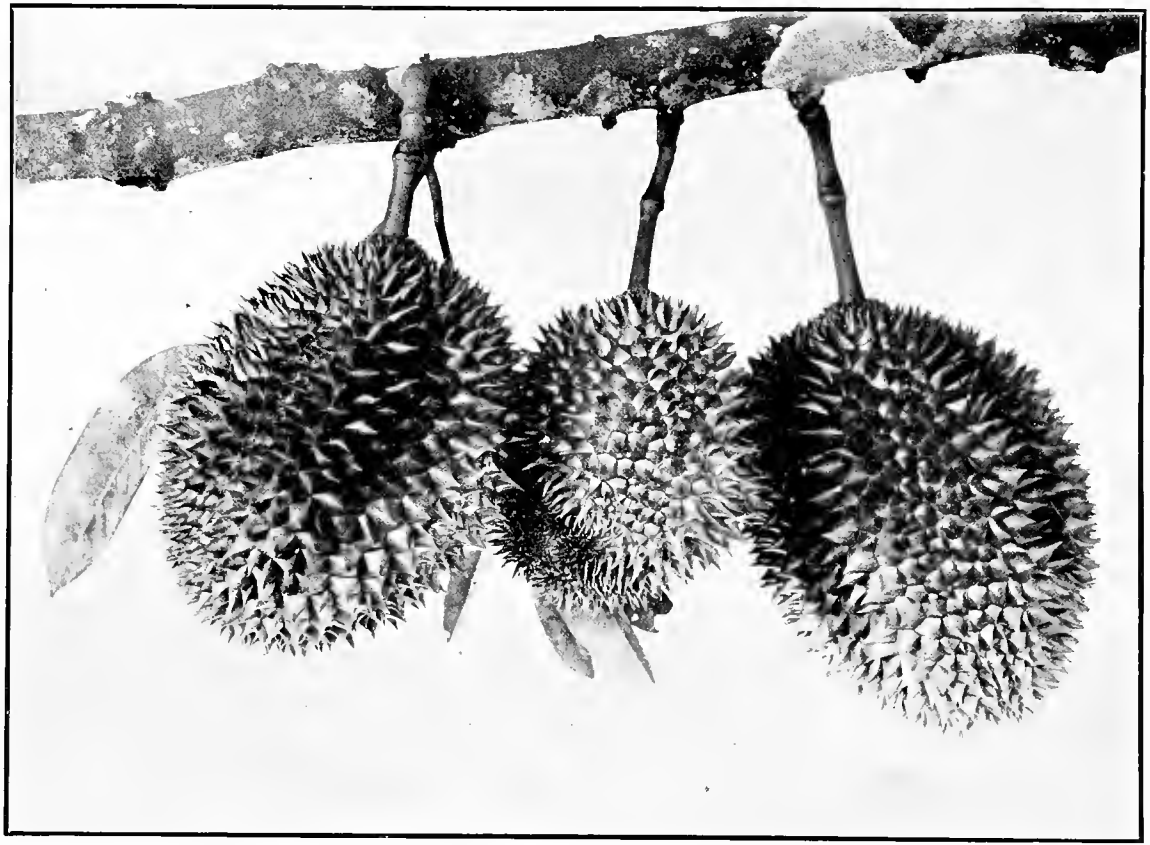
The rise in the value of exports in 1920 is due partly to the revival of trade, immediately after the war, and partly to the fact that supplies of tin plate, practically unobtainable during the war, were more available. The principal country for export is the United Kingdom, but Canada, British India and the United States of America absorb fairly large stocks.

Cultivation of Pineapples for Canning. The variety most commonly grown for canning is a "Queen" type of pine, which is very similar to the "Red Jamaican Pine" of the West Indies. The fruit is very small, weighing from 3 to 5 lbs. and has an excellent flavour when tinned. The "Mauritius" and the "Smooth Cayenne" or "Kew Pine" are chiefly grown for dessert purposes.

Although the pineapple will grow on most soils, provided they are well-drained, it usually thrives best on the stiff clay types of soil. A rich soil appears to be unsuitable as it tends to develop the size of the fruit at the expense of the flavour. Pines grown on some of the poorest Singapore soils have the best flavour when canned.

Planting:—The pines are propagated usually from suckers which are obtained from the base of the fruit, the suckers being allowed to dry slightly in the sun before planting. They can be propagated also by means of the off-shoots or suckers from among the lower leaves of the plants.





DURIAN. *Durio Zibethinus*

A common method of planting is in rows 5 feet apart, the plants being spaced 2½ feet apart in the rows, with a 6 foot path at every 100 feet. About 3,000 suckers are required to plant up an acre.

After planting, the fields require careful weeding, but are not generally manured. Fortunately the pineapple has few insect enemies and is not subject to many diseases.

Yield of Fruit:—The pines begin to fruit at from 12 to 18 months and during the first year of fruiting will produce one fruit per plant, but with good cultivation they should produce an average of about two fruits to each plant every year after the first year of fruiting. Under ordinary conditions the average yield of pines is about 4,000 to 5,000 per acre per annum.

There are usually two main crops during the year, the first in May and June and the second in November and December, but the crops depend very much on rainfall. When there is a spell of dry weather of long duration the pines do not fruit.

A properly cared-for estate, as cultivated in the Straits Settlements will produce good fruits for 5 to 6 years, after which the pines gradually become smaller and it is usually found necessary to remove the old plants and replant strong fresh suckers.

Canning:—The pineapple canning or tinning industry is in the hands of Chinese merchants. In the Straits Settlements the pines are always peeled and cut by hand as hand labour is found to be more economical. The peeler wears a rubber glove on the left hand as a protection from the juice of the fruit. After peeling the pines either whole, in slices or in cubes are placed in tins, which are filled up with either water or syrup. In the case of whole pines the cores are removed previously, if required, by a tin tube which is pressed through the centre, but most pines are tinned without coring. The syrup consists of about 3 parts of sugar to 100 parts of water but is varied with the ripeness of the fruit. After the pine is put into the tin, the tin is soldered up and a number of tins are placed on a wooden rack slung on wires and plunged into a rectangular tank of water heated by means of steam-coils. The tins are boiled in this tank for ten to fifteen minutes in the case of the smallest tins and up to an hour for large tins, the biggest tins weighing 5 pounds when full. After removal from the boiling water a puncture is made in

the top of the tin with a hammer and punch ; in large tins two punctures are made. This is done to allow the steam to escape; the holes are resoldered and the tins plunged again into boiling water for about nine minutes. They are then labelled and packed in boxes for export.

The forms manufactured for export are (1) whole pines (2) sliced pines and (3) chunks or cubes. The most popular size is the 1½ lb. tin, these are shipped in wooden cases containing 4 dozen tins.

The present market price (January 1922) of $10 per case for sliced pines and $11 for pine chunks is somewhat lower than usual, the average price being about $12 and $13 per case for the respective grades.

Machinery : The greater part of the machinery employed in the canning factories is necessary for the manufacture of tins and consists of tin plate cutting machines, cover and bottom presses, and rolling machines for making the tins. The tin plate is imported from the United Kingdom and the tins made completely in the canning factories in Singapore.

General:—Owing to the main crop maturing in two comparatively short seasons during the year, the working of the factories is very irregular and it is necessary to employ much surplus labour during the height of the fruiting seasons. The prices paid for pines are somewhat high at the beginning and end of the seasons, but they are, as a rule, so low during the height of the May/June crop that the grower gets practically no profit.

There is usually a small supply of fruit available between the main cropping seasons, and the canner has to rely on this to keep his factory running during these periods. The supplies are usually supplemented by purchasing fruit from outside sources where the fruiting season does not coincide with that in Singapore, and fairly large quantities are shipped to Singapore from Port Swettenham: when it has to be transported such long distances, the fruit is cut just a little under-ripe. Towards the end of 1921 there existed about six canning factories in Singapore and two near Johore Bharu on the mainland.

Bananas—*(Musa Sapientum).*

The banana or plantain is to be found cultivated throughout the whole of the tropics on account of its highly nutritious fruit. It is undoubtedly the commonest fruit on the local markets, where it is sold chiefly for dessert purposes. A large number of varieties is cultivated and it is impossible to describe them all in this handbook.

Cultivation.—The banana flourishes best on heavy soils fairly rich in organic matter and in moist situations, providing the soil is well-drained. The plant is liable to be damaged by heavy winds and should not be planted in exposed situations.

It is propagated by suckers, which arise from the roots of the parent plant. Suckers for planting should be selected only from vigorous plants. The land selected should be cleared and then carefully holed and lined ready for planting. The holes should be fairly large and filled up with good soil, cattle manure or humus. The average distance of planting is from 10 to 15 feet apart according to the particular variety to be planted. If planted in dry weather, a mulch of cut grass should be placed round the suckers to prevent excessive evaporation. Weeds must not be allowed to grow immediately round the plants and the soil should be frequently stirred.

The banana plant appears to utilise a large proportion of potash from the soil and all parts of the plant are rich in potash. In Queensland the application of potash fertilisers has been effective in increasing yields.

The first bunch of fruits is produced about a year from the date of planting, but this depends upon the variety grown. The plant will throw out several suckers, forming a clump, but only four or five of these should be allowed to grow. After removing the fruit the stem should be cut down to allow the subsidiary suckers space to expand. With good cultivation these will soon bear fruit and the plant continues to be productive for four to six years, during which time it will yield an average of two bunches of fruit per annum.

Banana Flour:—A new industry, which has recently been started in the West Indies is the manufacture of banana flour.

Any kind of banana or plantain is suitable for the preparation of banana flour but, for economic purposes, the varity

which produces the largest weight of fruit (excluding the skin) should be grown, apart from other considerations, such as liability to attack by pests and diseases. In this country the "Pisang Raja" on account of the size of its bunches, size of fruit and high ductivity, is recommended as the most economical variety for flour.

The bunches should be cut when about three-quarters grown, otherwise the fruit will become too ripe and the starch be converted largely into sugars.

The bananas are peeled, sliced thinly, with a nickel, bamboo or other knife which does not darken the fruit, and the slices laid on wooden trays in the sun to dry. Under good conditions the drying takes two or three days. The dried slices are crushed in a corn mill or pounded in a mortar, and sifted through fine muslin.

On a large commercial scale, artificial drying is resorted to, this is carried out preferably in vacuum driers at a low temperature, or in special chambers or rooms in which the peeled and sliced bananas are placed on trays on endless travelling belts or conveyors and dried by forcing or drawing hot air through the chambers.

Uses.—In this country large quantities of bananas are consumed either as dessert or cooked as food, and very little, if any, fresh fruit is exported.

A large quantity of fresh fruit is consumed in the United Kingdom, where it is estimated that over 9,000,000 bunches are imported annually, principally from the West Indies.

A new and rapidly increasing trade in the West Indies is now being carried on with dessicated bananas, which are used in the manufacture of banana flour, the latter having the peculiar flavour and odour of the fresh fruit.

Banana meal or flour is highly nutritious and very digestible and is used largely as a food for invalids and infants.

General:—The banana can be produced so cheaply in this country that it should be possible to ship fresh fruit to the Southern and Western States of Australia, and, provided ships on the Singapore—Australian route were fitted with special refrigerating space there appears to be no reason why

a profitable trade should not be developed between the two countries. The fruit can be purchased on the local markets at considerably less than a cent each and, if delivered in good condition, could probably be sold in Australia at a price equivalent to 5 or 6 cents.

There is at the present time a small import duty on bananas in Australia but, in spite of this, fairly large quantities of the fresh fruit are now being exported to that country from Java.

Limes—(*Citrus medica, var. acida*).

The lime is cultivated to a greater or less extent in all tropical countries for its acid juicy fruit, which is used principally in the manufacture of cooling drinks. It is grown as a commercial product in the West Indies and the export of concentrated lime juice and citrate of lime forms the chief industry of the island of Dominica.

Formerly, citric acid was obtained from the Sicilian lemon (Citrus medica, var, lemonum), but during recent years the lime has to some extent taken its place.

The lime plant requires careful attention in its cultivation and if grown under unfavourable conditions it is subject to severe attacks by both insect pests and fungoid diseases, which will affect the yield of fruit to such an extent as to render cultivation on field scale unremunerative.

Cultivation.—A rich loam soil on flat ground is considered the most suitable for the cultivation of limes, although it will thrive on most soils except stiff clays.

The plant is propagated from seeds or cuttings, but budding and grafting are frequently adopted. The seed is usually sown in carefully prepared nursery beds, which should be 5 feet wide, slightly raised above ground, and shaded. The seeds should be sown in lines 8 or 9 inches

apart, with an interval of 2 to 3 inches between the seeds in the lines ; sufficient seed should be sown to allow for losses in the field. When the seedlings are four to five inches high they should be transferred to other nursery beds, where they are replanted 6 to 9 inches apart, the tops being nipped off to produce a thick well-branched tree. When the seedlings are about one foot high, they should be planted in the field. The common distance of planting is 15 to 20 feet apart according to the nature of the soil ; the richer the soil the greater the spacing.

Mature lime trees are not usually clean-weeded except for a small area round each tree, but the grass between the rows should be cut regularly.

Careful attention must be given to pests and diseases and a sharp watch should be kept for plant parasites, which are very liable to attack the trees. Scale insects are usually the most troublesome pest.

Under ordinary conditions the lime tree commences to fruit at from three to three and a half years from the time of planting and at six to seven years will give an average yield of 1,500 to 2,000 fruits per tree per annum.

Although the plant produces fruit more or less throughout the year, fruiting is usually more pronounced during two periods, following the wet seasons.

It is estimated that on well cultivated estates in the West Indies one acre of limes will yield 24,000 lbs. of fruits equivalent to 11,550 lbs. of raw juice, or 914 lbs. of citric acid. In addition 65 lbs. of hand-pressed oil are obtained from the rind of the fruits.

Commercial Products. The products of the lime which are in demand commercially are :—

(1) *Green Limes.*—Consisting of specially selected fresh fruit.

(2) *Pickled Limes.*—Yellow selected limes steeped in several changes of sea-water and shipped in casks of sea-water to which salt has been added.

(3) *Raw Lime Juice*—Prepared by expression of the fruits and containing normally 12 to 14 ozs. of citric acid per gallon of juice.

(4) *Concentrated Lime Juice.*—Prepared by evaporating raw juice in either open or vacuum pans.

(5) *Citrate of Lime.*—Prepared by raising the raw juice to boiling point by means of steam coils in large, lead-lined, wooden vats and neutralising the acid of the hot juice with milk of lime. The citrate of lime thus produced as an insoluble precipitate is allowed to settle and the clear liquor run off. The product is then dried by heating. In the preparation of a high grade product further details in manufacture must be observed.

6. *Essential Oils.*—derived from the rind or peel.

(*a*) Hand pressed oil is extracted from the rind of the fruit in a special machine before crushing in the factory and (*b*) Distilled lime oil is obtained from the raw juice by a preliminary distillation of the raw juice before evaporation in the preparation of concentrated juice.

Uses of Commercial Products.—Fresh and pickled limes are used for the preparation of cooling drinks and for flavouring purposes; raw lime juice is used in the manufacture of lime-juice syrups and cordials. Citric acid, produced citrate of lime, is used largely in connection with the textile and dyeing industry and in the manufacture of other fine chemicals, while the essential oils are employed in perfumery, as a flavouring for essences and confectionery, and in the preparation of scented soaps.

Market Prices.—In May, 1921, the quotations for the various commercial products obtained from lime fruits were as follows :—Concentrated juice £25 per basis (6 cwt.), Citrate of lime £28 per basis (6 cwt.), Hand-pressed oil 21s. 6d. per lb. and Distilled oil 3s. per lb.

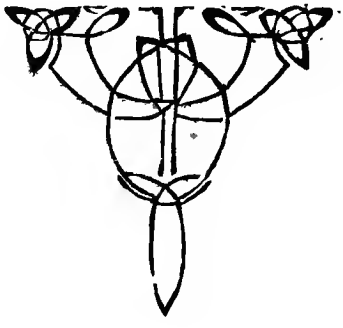
Citric Acid.—Until recently the product of the fruit was exported from the West Indies in the form of raw juice, concentrated juice or citrate of lime, but attention is now being directed to the manufacture of citric acid in estate factories.

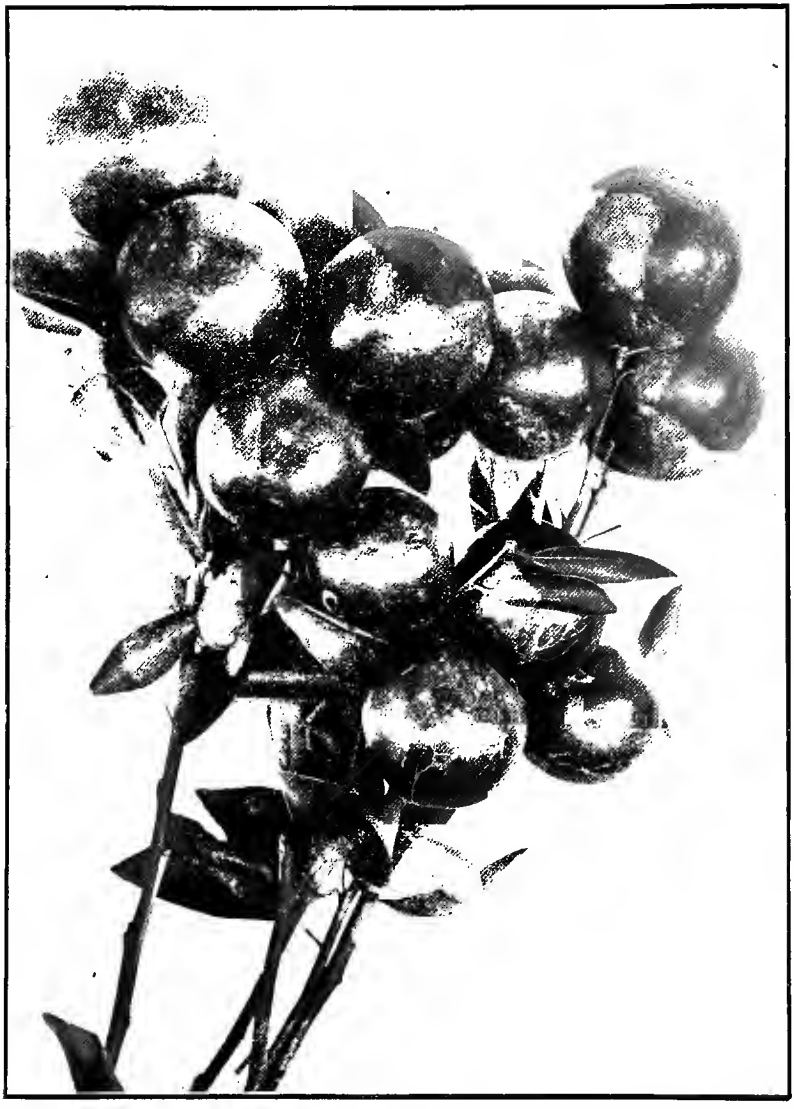
Citric acid is usually prepared by treating the citrate of lime with sulphuric acid, sufficient acid being added to convert the whole of the calcium citrate or citrate of lime into free citric acid which remains dissolved leaving the calcium sulphate formed in the reaction as an insoluble sludge. The solution of citric acid is filtered from the insolbule calcium sulphate sludge in mechanical filters and the crystals of citric acid are obtained by evaporating the

clear solution to a concentration at which the crystals will separate from the solution on cooling. The exact point is usually determined by means of hydrometers.

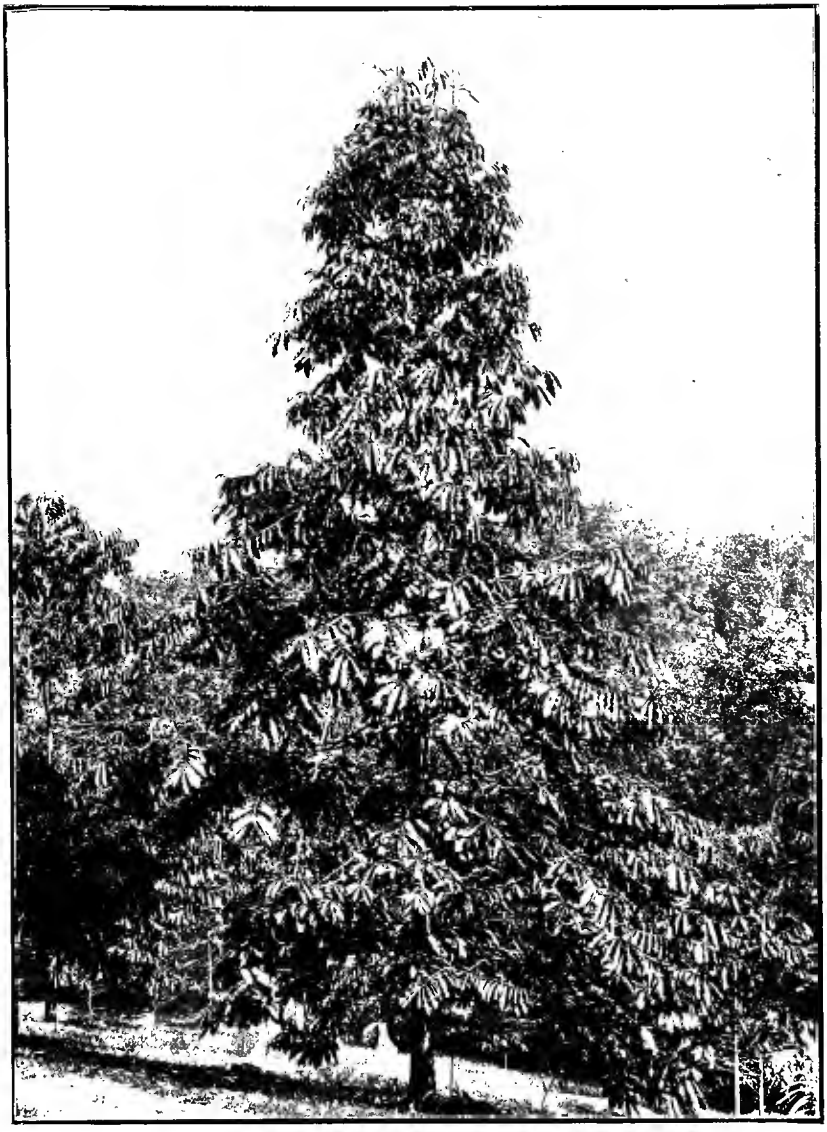
Careful factory control and some experience is required and in the manufacture of concentrated juice, and more especially in the manufacture of calcium citrate or citric acid, scientific chemical advice is necessary or desirable in the first instance, unless the factory superintendent has received preliminary training in connection with the manufacture of these products.

Possibilities in Malaya One estate in Malaya has already taken up the cultivation of limes on a small commercial scale and it is intended in the first instance to manufacture concentrated lime juice for which the necessary plant has been obtained. There should be a good Eastern and probably an Australian market for the products although whether this country can compete with the West Indies in the European and American markets remains to be proved. The chief difficulty at present is a suitable wood for barrels. In the case of citrate of lime or citric acid, which, are solids, this difficulty does not arise, since barrels constructed from suitable local wood, could probably be made. Wooden boxes or cases would also be quite satisfactory for the packing of citrate of lime or citric acid for export. In the case of the liquid products, raw lime juice, and concentrated lime juice, the barrels would have to be of better construction and of strong wood to prevent leakage. It is not possible in this Handbook to include full details of the processes of manufacture of the various products, but full information can be obtained on application to the Department of Agriculture in regard to methods and machinery and cost of plant required.





MANDARINE ORANGE. *Citrus nobilis*



BRAZIL NUT. *Bertholletia excelsa*
A 10 year old tree at Kuala Lumpur Experimental Plantation

Vegetables.

Cultivation and Improvement.

Local Vegetables.

CHAPTER IV.

Vegetables.

A LARGE quantity of vegetables is grown by the small holder throughout the Peninsula, but the individual areas are relatively small and there is no well-known market garden in the country.

The small gardens are, in their way, very well cultivated and excellent results are obtained; but it is entirely by hand labour, and it is unlikely that the small holder, with his limited capital, will be able to extend materially, or to utilise modern types of implements for the cultivation of his crops. It must be recognised that the Chinese are wonderful vegetable growers, and had they the opportunities of adopting Western methods of tillage their results would no doubt be all that could be desired. Under existing conditions however, the Chinese are to be congratulated on the way in which their gardens are managed. They take immense trouble in the preparation of the ground and apply almost unlimited quantities of manure until the land is in first class condition. The care devoted to the plants themselves is another feature of their ability as vegetable growers. Even a casual observer

cannot fail to observe the remarkably fine appearance of the average Chinese market garden. The Tamil is an agriculturist at heart, but apart from growing a few vegetables around his dwelling he has not here made any special progress in this direction. The Malay takes little or no part in the production of vegetables. The capitalist of the country at present looks mostly to rubber and coconut cultivation as an investment and has probably never considered seriously the possibilities of vegetable or fruit culture. It is surprising that around the large centres there is not a single instance of production on a large scale, and there is certainly room for a profitable development in this direction. The tropical vegetables are well represented, but there is a considerable quantity imported, principally from Java, and there is no reason why vegetables, of this class, should not be entirely grown in the low country. It must be remembered that the cost of packing such produce is expensive, and this, combined with sea and rail freights, amounts to a figure which should make it profitable to grow them locally.

European vegetables, such as potatoes, carrots, beet, etc. are almost entirely imported, and although they cannot be grown successfully on the lowlands, there is ample scope for their cultivation on the hills, where they have been proved to do well. In India and Ceylon these crops are extensively cultivated on the hills and the markets derive a good supply from this source. There is no apparent reason why this cannot be done in Malaya, it has however only once been tried on a commercial scale. This was commenced only recently and, so far, the results have been satisfactory.

The importation of potatoes alone should be sufficient in itself to warrant the opening up of large areas on the hills at suitable elevations. There can be no doubt that were European vegetables grown on the hills they would meet with a ready demand, since market produce is not always grown in strict accordance with sanitary principles.

There is room for extensive development of market gardening, both on the hills and in the low country, during the past few years, considerable interest has been taken by residents in Malaya in the growing of vegetables for their own use but it is surprising how few take a keen interest and utilise waste ground which might be turned into a profitable kitchen garden.

There are many factors which require to be taken into account. The situation should be an open spot and preferably on a slope, facing east. A good water supply, conve-

niently situated, is essential. The type of soil is very important and the Chinese market gardeners pay the utmost importance to the selection of land with abundance of humus. Deep loams, or alluvial soils, rich in humus and moderately light, are best suited for the growing of vegetables and require the minimum amount of preparation, Sandy and laterite soils require heavy and repeated applications of organic manure. Clays, on the other hand, are too heavy, cold and damp, and are as unsuitable as barren sandy soils. It is not to be expected, however, that either very light or heavy soils—particularly the latter—will ever attain the same degree of perfection as a naturally well-balanced alluvial soil. One of the principal features in vegetable growing is the maintainance of a high class tilth, and this can be obtained chiefly by thorough tillage. Tillage makes the soil more porous and permeable to roots, enables vegetable and mineral matter to decompose more rapidly, promotes oxidation and stimulates the activity of the nitrifying bacteria, checks the growth of weeds and reduces evaporation of soil moisture. The depth of cultivation required will depend on the nature of the soil and vegetable grown.

Manuring is as important as tillage, and frequent applications of one or more organic manures, such as cattle manure, fish refuse, guano, oil cake, leaf mould, etc. are required in order to maintain soil fertility. Well rotted cattle manure is the best form of organic manure for vegetable cultivation.

The judicious planting of successive crops, in rotation. is of considerable importance. A rotation of crops is resorted to in ordinary practice in consequence of the economy of manure and variation of root growth which result from this practice. Certain crops are subject to special diseases, and the eradication of such diseases is often effected by the introduction of other types of crops. Plants of the same order should not follow each other. Deep and shallow rooted crops should, as far as possible, be grown in succession. A leguminous plant should be included in the rotation.

The source and storage of seeds must receive careful attention. It is of primary importance in the combatting of insect and fungoid attacks to ensure that the plant is maintained in a vigorous condition by good cultivation. When practicable, hand picking of insects should be resorted to; this applies in particular to the numerous species of caterpillars which feed on stems and leaves.

Several fungoid diseases do considerable damage and are kept in check preferably by strict plant sanitation. Good cultivation and drainage, judicious manuring, rotation of crops, isolation of infected areas, destruction of diseased plants or tissues, freedom from wounds, artificial watering and careful pruning when necessary, are factors which tend to reduce the possibilities of attack and spread of disease.

In making a selection of vegetables for the garden there are numerous factors that require consideration before arriving at a decision. In small gardens a selection of edible leaf and stem vegetables should be grown as these cannot be bought from the local market with any degree of safety. Of the root crops, the sweet potato is the most important one cultivated here. The sweet potato is eaten by all nationalities in Malaya and forms an important article of diet with the Chinese. There are numerous varieties, but of the two commonly grown in this country, one reaches maturity in about three months from the time of planting, while the other takes six months. The former type is the more popular. One variety recently introduced, known as New Jersey Red, produces a large tuber of excellent flavour. Experiments have shown that the largest crops of sweet potatoes are grown in land that has been ridged. This tuber can be grown on any moderately good friable soil. Propagation is effected generally by cuttings from semi-mature portions of the stem. As a sole crop, the ordinary early-maturing variety will produce a yield varying from two to three tons per acre. The cost of growing a crop of "three months" sweet potato is approximately twenty-two dollars per acre.

The yam is another important root crop in this country and can be grown successfully on comparatively poor land; a sandy loam is preferable, but deep cultivation and good drainage are more important than quality of soil. The crop takes from nine to eleven months to mature. Yams are propagated from sets taken from the mature tubers. An average crop is about six to seven tons to the acre, costing from thirty five to forty dollars to produce.

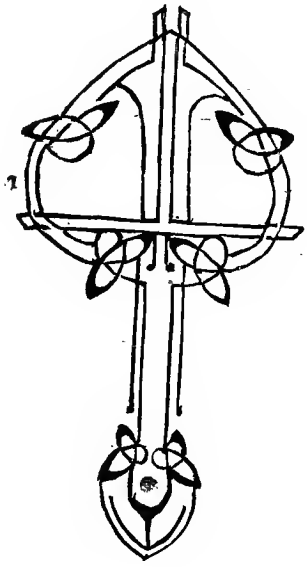
The Keladi (*Colocasia antipuorum*) is grown to some extent by the Chinese. In the West Indies it is a well known crop and is an important tuber vegetable.

The Jerusalem Artichoke is cultivated locally and is a favourite vegetable with Europeans. The yam bean (*Pachyrhizus tuberosus,*) and elephant yam (*Amorphophallus campanulatus*) are worthy of mention as subsidiary root crops.

The French or kidney bean, Egyptian kidney bean, four-angle bean, lima bean, sword or jack bean, cowpea and pigeon-pea can all be grown in the low country ; also lettuce, tomatoes, onions, maize, parsley, and water-cress. Some of the favourite native vegetables which can be grown successfully on the plains are the gourd, brinjal, ceylon-spinach, chillies, chocho, endive, ladies fingers, loofah, lotus, pumpkin, shallot, and snake gourd.

Comparatively little success can be obtained at low elevations with the following vegetables :—asparagus, beet, cabbage, carrot, celery, potato, leak, parsnip, radish, turnip and vegetable marrow, but all of these crops can be grown successfully on the hills.

A special bulletin No. 26 on "Vegetable Culture in Malaya" was published by the Department of Agriculture in 1919.



Rubber.

Research and Rubber Growing.

Selection in Hevea.

Vegetative Propagation.

Modern Estate Practice.

Manufacture and Factory Methods.

CHAPTER V.

Rubber.

THE programme of the British Cotton Industry Research Association lays down as two possible lines of advance :—

(1) "To attack problems directly by methods based on past experience without seeking to investigate the fundamental nature of the process."

(2) "To try to understand the chemical and physical changes produced during manufacture, and so to establish gradually a broad roadway along which future advances may be made."

If for "manufacture" be substituted "growth" an excellent definition of the aim of the best form of scientific research for the improvement of any crop is obtained. Unfortunately this fundamental method is almost painfully slow and laborious, and the first method is bound to be employed at the birth and during the youth of any industry.

Research and Rubber Growing. As it happens, the Para rubber tree is a plant concerning which it is decidedly dangerous to argue from analogy, and even now nothing is known of the processes involved in the formation of latex. Realising therefore that the present plantation practice is the result of dearly-bought experience in the laboratory and in the field, the methods by which modern scientific research may be expected to assist plantation companies to pay the largest dividends over the longest possible period are, in one form or another, the object of all agricultural work. Apart from economic factors, such as effect of increased production on selling price, the principal methods must be those for the improvement of yield per unit area (due regard being paid to the cost of collection) at the same time preserving the trees in a perfect state of health over as long a period as possible.

The means adopted for the attainment of these ends are set forth in this Handbook in articles on "Rubber", "Pests and Diseases" "Selection of Hevea" and "Budding of Hevea."

In the case of new areas, considerable expectations have been aroused by the benefits which it is hoped to derive from the planting of selected stock. From some points of view attention would appear to have been unduly concentrated on what is after all an experiment, affecting the relatively small area likely to be planted in the immediate future. It is necessary to point out that expectations of this nature are based on *a priori* arguments and not on actual results, and it remains to be proved that the variability admittedly existing in rubber is fixed, and that high yield can be transmitted from parent to offspring.

It is not suggested that selected stock should not be planted, but that planters should realise that their hopes may not be fulfilled. It would certainly be inexpedient at the present time to plant widely (say 50 trees, per acre) in the hope that all the trees, because selected, will be high yielders.

Recognising the real need for research of the second type, the Federated Malay States Government has recently added a section of plant Physiology to the Department of Agriculture. This section has for its main object at present the recognition of some of the factors affecting latex yield. No immediate results are expected, but if, after as long a time as a decade, the most important of these could be selected from the present welter of possibilities, much will have been achieved.

Leaving aside strictly agricultural methods, it is permissable to doubt whether perfection has been attained in agricultural economics and organisation on the majority of estates, whether for example, attention to the harvesting powers of workers would not be quite as important as attention to the yielding powers of trees. A similar point is the economic size of plantations ; it would seem at least possible that more economical working might be attained by amalgamations of smaller properties.

The working out of these latter problems however, would appear to be outside the scope of an Agricultural Department.

Selection of Hevea. Although much has been said and written on this subject, in the absence of experimental proof of the success of the methods which have been suggested and adopted from time to time, it still presents a vague aspect. Thus, the problem of Selection of Hevea is still new and relatively unexplored territory and sorely needs the application of all our knowledge of genetics and horticulture in order to produce high yielding races of rubber trees. "Hevea" is probably the most recent plant brought under cultivation and as such has not yet been affected by the selection which man applies, consciously or unconsciously, to all useful plants. The general method of thinning out by selection based on yield, will slowly but surely tend to improve the yielding capacity of our trees, though, being perennial plants, capable of living to a fair age, no appreciable effect is likely to be detected within two or even three generations of man. It is still open to doubt whether seeds of the best types of Hevea were imported into the East in the first place, but it cannot be disputed that the scope for selection amongst the trees on our plantations is very wide. This latter fact is amply disclosed by a study of the accumulated mass of data regarding the variation of our populations of trees. Whatever method of plant improvement is applied to Hevea, it involves in the first place, a choice of parent trees, which necessitates a systematic study of the variation between individual trees on a plantation. During the past seven years a considerable amount of investigation has been carried out in this connection in all Eastern rubber producing countries.

Whitby, Cramer, and several others have published interesting and conclusive articles proving variation in Hevea in almost all its parts, leaves, seeds, bark, branches root systems, and in quality and quantity of rubber etc., but we are concerned chiefly in dry rubber production.

The Botanical Division of the Department of Agriculture has figures extending over two years, which show that the variation in latex production per alternate daily tapping from a population of approximately 500 twenty-eight year old trees ranges from practically nothing up to 15 ounces or from 0 to 45 lbs. of dry rubber per tree per annum. Moreover, of this population, not less than 11 trees yield over 28 lbs. dry rubber per annum, with alternate day tapping on a V on half the tree, and in every case the cut was situated during the entire tapping period, more than one foot above the base of the tree. The magnitude of the variation in dry rubber production is thus very apparent, and it is clear that if pure races of these heavy yielding trees can be produced, then acreage productions on our estates will be vastly increased. The crux of the situation lies in the problem of isolating and propagating pure races of these heavy yielding trees. This problem must be considered as distinct from that of the breeding of trees resistant to diseases or possessing other district characteristics.

Two courses are available to the experimentalist:—

Seed Selection.

Vegetative propagation.

Seed Selection:—(i) mass selection; (ii) pedigree selection. It has been found that large heavy seeds of Hevea germinate more rapidly and produce stronger seedlings than those derived from small and light seed, because they carry more food for the young plants and give them a better start in life. Therefore a rough grading of seed into light and heavy groups with consequent use of the latter only, will produce healthier nurseries than can be obtained from unsorted seed, and thus ensure healthy stock for planting. This method is very superficial and does not take into account the inherent quality of each seed; nevertheless, in mixed populations it is likely to have a good effect and is one of the few practices which every planter can adopt. Present methods of thinning out trees by selection based on the health and yields of individual trees is really a form of mass selection, though its effects can only be seen in the progeny derived from seed obtained from estates thinned in this manner, and the results depend on the intensity and thoroughness of the selective thinning. It would be advisable for each large estate to mark its best area for seed production and to adopt a very strict programme of thinning on an area say of one hundred acres for this purpose. In a block of this nature

the intensity of the selection of parent trees could be increased from without inwards in such a way that the middle twenty acres would contain only sound well developed trees of pronounced yielding ability. The seed for the nurseries for supplying new clearings could then be taken from the innermost five acre block. Such seed, resulting from cross pollination between high yielding trees, can reasonably be expected to produce trees of better yielding capacity than the average progeny derived from seed which has not been selected in any way.

At the same time, it must be understood that the progeny from seed selected in this manner is likely to contain a proportion of poor yielding trees because the constitutions of the parent trees are unknown ; but on well-managed estates this proportion would soon be reduced considerably by ordinary selective thinning operations. Thus, though plantations of better yielders than the average are likely to result from this method of seed selection, the method can never give rise to a uniform highly productive plantation, because it is based on the chance combinations of hereditary characters in previous generations of cross-fertilised trees; it is a useful method however that can easily be put in practice.

Pedigree seed selection is by far the best means of improving our plantations permanently but can only be attempted by trained botanists preferably in Government employ in order to ensure the continuity of work which must spread over more than a dozen years. In order to obtain a high yielding healthy strain of Hevea it is necessary to isolate a single strain, possessing the required characters, which will breed true to type. Through cross-fertilisation in several generations, the present plantation rubber tree is of very complex nature and to isolate such a strain requires a large amount of systematic work, especially since at least three characteristics are involved, namely yield, quality, and disease resistance. Work of this nature has been initiated in Java, though little is known as to its progress to date.

Vegetative Propagation :—Methods of propagating vegetatively good yielding parent trees may be divided into two groups, those providing for their own root system, and those in which one tree is grafted on to another. It is probable that the root system is as important to latex production as are the parts above ground. Methods of developing root systems include marcotting and cuttings. The former has been carried out successfully in Java but it is laborious and difficult and requires horticultural experience.

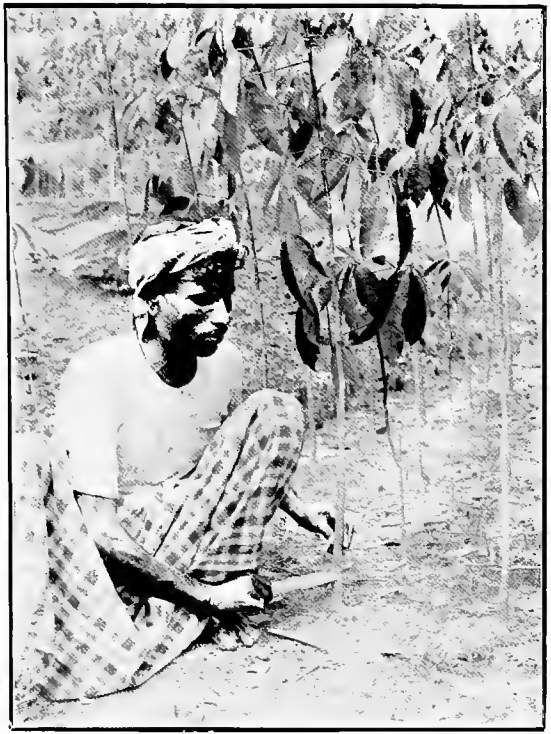
Cuttings carry with them the characteristic root system of the parent tree as far as is known, and if the roots develop well this method of propagation is to be preferred to all others. Unfortunately this method of propagating selected parents has not, so far, been sufficiently successful to warrant its adoption on estates, but experiments are still in operation. Methods whereby a high yielding, disease resistant tree is grafted upon another root system are numerous. One of the simplest is budding, which has already been carried out successfully on many plantations, although the question, whether the yielding ability of the parent tree, from which the bud is taken will be unaltered by the new root system of the stock on to which it is grafted, is still problematical and awaits proof.

All methods of selection involve careful choice of parent trees and these can only be chosen after definite data and recorded observations have been taken over not less than a complete annual cycle, though an extension to several cycles would give proportionally more reliable figures. The chief factors which should be considered in selecting parent trees are (i) age, (ii) disease resistance, (iii) yield, (iv) robust growth, (v) good bark development, (vi) quality of latex, (vii) situation, (viii) history; though much has been done already in the way of selecting parents, there is still a wide field for research in connection with the study of methods of propagating them and of maintening pure races of good yielding trees.

Budding of Hevea :—The operation of budding Hevea is comparatively simple provided certain precautions are taken. As far as the actual practice of budding is concerned, the work is now on an established basis and employed on a number of estates that are planting rubber. As to whether these areas, when in tapping, will give the yields that are anticipated remains uncertain.

The trees that have been selected as the heaviest yielders on any particular plantation will provide the material for future planting. It is necessary to raise nurseries of robust seedlings as stocks for budding from the selected trees, The seedlings are ready for budding when from six to twelve months old; older stumps that have already been planted out in the field, are not recommended as stocks. Budding should not be performed during the wintering period or during wet weather.

A sharp knife and a supply of waxed binding cloth are required. Ordinary unbleached cotton cloth is suitable and



Budding Hevea seedlings

Stump four months after budding

Centrosema Plumieri, AS A COVER-CROP UNDER YOUNG RUBBER
in Pahang

is readily procurable. For waxing, the following ingredients are recommended:—

50 per cent Petroleum Jelly (Paraffinum molle flav).

50 per cent White Paraffin Wax (melting point 120°/130°F.)

These substances are melted together in a kerosene tin over a fire, and after thorough mixing, the mixture is ready for waxing the cloth and is removed from the fire. A convenient size for the cloth is 16 inches wide by 10 yards long. The cloth is immersed in the warm liquid wax and subsequently hung over a frame in a cool shed to dry. After cutting into strips 16 inches long by 1 inch broad, the cloth is ready for use.

Mature bark only should be used as "bud-wood" and it must peel readily from the branches of the mother tree. The branches should be removed from the trees early in the morning and be cut into short lengths; they are then stored in kerosene tins and covered with damp sacking to prevent evaporation.

A rectangular tongue of bark, 2-3 inches long by one third the circumference of the stem is lifted at the base of the stump, and a bud, attached to a piece of bark of approximately the same size, from the selected tree, is inserted beneath. Buds are readily distinguishable upon close examination and are situated immediately above a leaf-scar. It is not necessary for the bud-patch to fit the excised area on the stock exactly, as this space serves as an outlet for the latex which exudes from the patch. On cutting the bud-patch from the branch, a portion of wood is frequently removed also; this must be taken out with the point of the knife. The bud-patch after insertion is covered by the tongue of bark on the stock and then bound up with a strip of the waxed cloth which when rubbed over gently with the hands becomes softened and adheres to the stem. To prevent the latex from the stock forming a film over the exposed cambium and thus preventing the proper union of the stock and the bud-patch, it is necessary to outline a number of the incisions a short time before the bud is actually removed and inserted beneath the tongue of bark of the stock.

After two weeks from the time of budding the binding is removed; the tongue of bark is cut away and the bud-patch examined. Failures may have another bud inserted on the opposite side of the stock and be treated as before.

The successful stocks are left for a week, when they are cut back to within a foot of the living bud. Any lateral shoots that appear must be removed. The majority of the buds will sprout within a month, but 25 per cent may take as long as six months to grow. The stocks are ready for removal to the field when the sprouting bud is from one to three inches long. After the young trees are firmly established the upper portion of the stock should be sawn off to within one inch of the growing bud. A skilled coolie should be able to bud about 200 stocks a day with a proportion of successes varying from 75 per cent to 90 per cent.

It is possible by marcottage of the young tree when one year old to propagate it actually on its own roots; the stock serving as a temporary feeder only.

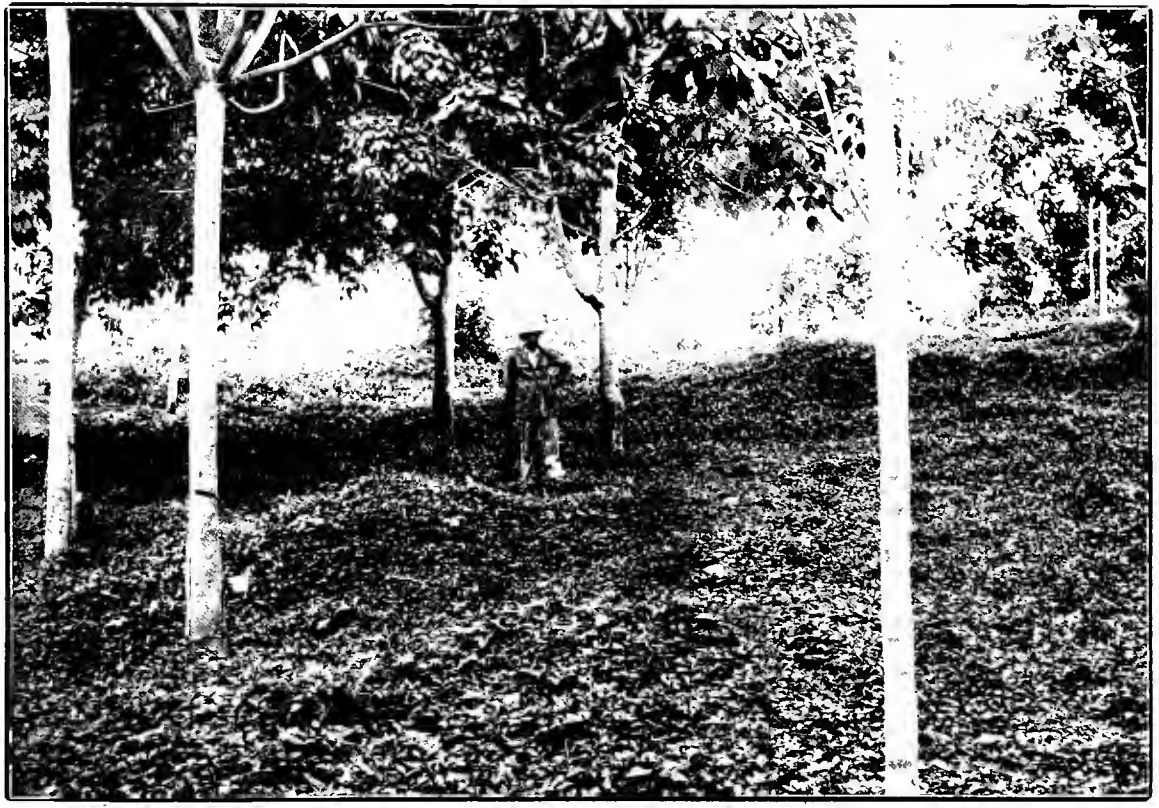
Further information on the vegetative propagation of selected stock of Hevea is contained in the *Agricultural Bulletin*, F.M.S., Vol. IX, Nos. 2 and 3.

Modern Agricultural Practice on Rubber Plantation. The remarkable adaptibility of Hevea to widely varying conditions of soil and situation in Malaya and other Eastern tropical countries has, in the past, led to neglect of many agricultural operations, such as tillage, manuring and soil conservation which are matters of routine in most other cultivations. In many cases this neglect has been justified by results, in others damage has resulted.

The only work which was early realised to be essential was the drainage of low-lying flooded coastal lands, but with increasing certainty of the permanence of plantations more attention is being directed to soil problems.

It is proposed to consider briefly various methods of treatment of the soil, which are considered necessary in certain circumstances and also problems which require consideration in regard to the plant itself.

Tillage:—Any extensive and deep cultivation of the soil is impracticable after the trees are more than about 18 months old and is in practice only carried out as an operation incidental to the removal of "lalang" when planting up such land. Shallow cultivation suffices for the prepatation of jungle soil. In a few cases deep changkolling (hoeing) or disc ploughing is resorted to and beneficial results have been claimed, but no controlled exprements are reported in Malaya,



Dolichos Hosei, AS A COVER-CROP UNDER YOUNG RUBBER

CASTOR OIL IN PAHANG

while recent work in Sumatra extending over three years shows no positive results following cultivation in the case of rubber of seven years of age. It seems unlikely that cultivation of the soil will ever become general, or that its adoption will be justified.

Weeding :—Clean weeding has long been generally adopted; in addition to freeing the trees from competition, supervision and movement are rendered easier and the light incidental cultivation is of value by breaking up the hard surface cake or glaze which is readily formed on some soils, and through which rain penetrates with difficulty.

On flat land there is much in favour of clean weeding but on hilly land it is thoroughly bad, and has resulted in considerable damage by soil wash. Realisation of this fact, together with the present need for economy, has directed increased attention to the use of cover crops.

Cover Crops :—The advantages of cover crops are reduction of working costs, by obviating weeding, and conservation of the soil. The disadvantages are difficulty of eradication, supervision, and movement, and in some cases of early identification of root diseases. *Centrosema Plumieri* is at present the most popular and useful cover for soil in good condition but cannot be established on poor or badly washed soils. Giant Mimosa (*Mimosa invisa*) will grow on comparatively poor and badly washed soils. It is necessary to confine this cover to strips between the rows of trees on account of the formidable spines on its stem. On undulating and hilly land, the cultivation of suitable cover crops, particularly leguminous plants, such as *Centrosema Plumieri*, is undoubtedly preferable to grass and weeds for the conservation of the soil, and is more easily eradicated if necessary.

Green manuring :—Green manuring i.e. the cultivation and digging of green cover crops, is generally unnecessary, but may be beneficial before planting up lalang-covered slopes, on which the soil is frequently friable and a poor water retainer.

Manuring :—Manuring has hitherto scarcely been practised, and except on worked out tapioca, gambier, or pineapple lands, Hevea has done remarkably well without the application of manures or artificial fertilisers. No experiments are available showing the effect of manuring on yield, and taking into consideration the almost universal

response of yield to thinning-out met with in Malaya, it seems improbable that good results are likely to accrue generally. The collection of latex involves the removal of negligible quantities of essential plant foods from the soil (e.g. a crop of 500 lbs. of dry rubber removing less than 2 lbs. of phosphoric acid ($P_2 O_5$) and there seems no strong likelihood that manuring will have to be resorted to generally for a very long period, except in cases where, owing to the previous history of the area the soil has become exhausted or on areas on which rubber should not have been planted, on account of original poverty or poor character of the soil.

In some cases it has been possible to correlate poor yields with the condition of the sub-soil and in such cases, any application of fertilisers would be entirely useless and economical.

The application of large quantities of bulky organic manure, such as cattle manure, would almost certainly be of value on some soils, which, owing to their previous history and cultivation over a period of many years, prior to the cultivation of rubber, are lacking in organic matter and nitrogen, but unfortunately such manure is available only to a small extent in Malaya. Good results however are said to have been produced by applying nitrates during the wintering season and field experiments on these lines are required in Malaya.

Liming:—The soils of Malaya are, as a whole, acid—some strongly so—but there is no evidence that acidity, as such, is injurious to rubber, although the resultant inferior soil texture may be. For this reason, improvement of mechanical condition by the addition of quantities of lime, small in comparison with the "lime requirement" (i.e. the amount required to neutralise the acid present) is frequently found to be beneficial. It would often be decidedly dangerous to apply the full amount of lime indicated by routine analysis.

Conservation of soil:—The prevention of soil wash on undulating and hilly land is to-day one of the most insistent problems confronting rubber growers. Wherever possible on such land, cover crops should be established, and in additon or as an alternative, if the slopes are at all steep, silt pits, terraces or bunds should be constructed.

Silt pits are trenches usually about 2 feet deep and 2 feet 6 inches wide and 6 to 8 feet long so situated that all but the

heaviest storm water with the suspended washed soil is caught and absorbed. The capacity of the silt pits should be sufficient to retain the heaviest rainfall during any period. A somewhat common error is to place the pits too near the foot of the hill, thus allowing a considerable movement of soil from top to bottom.

Terraces and bunds are probably better adapted to extremely steep slopes and should be laid down with a due consideration of contours.

In terracing, the establishment on the slopes of the terraces of a suitable cover crop or of weeds and grass other than lalang, should be carried out. A method of consvering soil which has been practised on estates in Sumatra and on at least one estate in Malaya is that of bunding.

The bunds are constructed by digging contour pits, the soil from there is used in the construction of a series of bunds, the site and frequency of which are determined by the slope of the land. After the main bunds are constructed, a careful watch has to be kept, after heavy rainfall, in order to deal with any particular points, such as the heads of rivines, which require special treatment. These methods, applied to undulating and hilly land are of value, not only in the conservation of the surface soil, but also in the retention of the rainfall in situ, an important factor in rubber cultivation.

It is important however, that such methods should be applied if possible, at an early stage in the planting up of an estate and not after much of the surface soil has already been removed.

It is important to realise that wash removes the entire top soil and not merely certain constituents; consequently the damage cannot be entirely repaired by manuring.

In addition to the operations described above for the conservation and improvement of soils, others which are connected with the trees and their yields such as density of planting and thinning out have to be considered.

Density of plantation:—On land which has not been completely cleared of jungle timber and stumps, 120—140 trees per acre should be planted in order to allow for losses by root diseases. Where clean clearing has been adopted and in the case of lalang land free from timber and stumps the stand

may be reduce to 100 per acre. It has recently been suggested that when budded stock is used, considerably wider planting may be adopted. This is however considered to be a distinctly risky proceeding in the present stage of ignorance of variation among such stock.

Thinning-out:—Disease and accidents may be expected to reduce the stand of trees on uncleared land at the end of the fourth year to 100 per acre; following this, will come the removal of obvious wasters (undersized bark-bound trees). This should give sufficient space for the next two years; at the end of this period, a certain number of consistently poor yielders will have been identified and removed, the stand thus being reduced to about 85 trees per acre by the end of the 6th year. Thereafter—if not earlier—disease should be the chief factor in thinning out and every precaution should be taken lest healthy trees which happened to be of moderate development and yield are removed, while diseased trees of better temporary yield and appearance are left, to die later, when every loss is serious. The ideal would seem to be 50 trees per acre in the eighth, thirteenth to fifteenth year, after which accidents (lightning, wind etc.) and disease may be expected to do all the thinning required.

On clean cleared properties there is pratical immunity from root diseases, but even on such areas tree to tree examinations are advisabze with stands of 65 or less.

Much discussion is taking place at the moment on drastic and early thinning out by selection, the argument being that a small percentage (say 30) of trees yield a large percentage (70) of the total crop. No records have been taken over a sufficient period to give certainty of the constancy of yield on the part of these high yielders; on the contrary, it is a fairly general experience in Malaya that exceptionally high yielders are to be regarded with suspicion, either as being already attacked by fungi or white ants or as being susceptible to Brown Bast. In any case, the response in yield to such drastic thinning would not be sufficiently rapid to compensate for a loss of 30 per cent of the crop for a considerable period—while only a small decrease in harvesting cost (itself a very insignificant proportion of the whole) could be expected.

Tapping systems:—There has been decided improvement in tapping systems in that more conservative tapping methods are coming into general use. Single cuts on one third and one quarter of the circumference tapped daily, and

the single V on one half the circumference tapped on alternate days are now the favourite systems, superimposed and half spirals cuts being relatively rare.

Alternate day tapping is gaining adherents both on account of economy and reduced liability of trees so tapped to Brown Bast.

After the first year of tapping the alternate day V cut may be expected to give 75 per cent of the yield obtained from a cut on one-third daily. In the first year, the comparison is much less favourable to alternate tapping, and where a quick return is of importance the trees might be opened up and tapped for twelve months on a third, changing over to alternate day tapping at the end of this period,

Conclusion :—To sum up, the general trend of thought is now to regard plantations as valuable permanent properties and to treat them accordingly.

When dealing with a slow-growing permanent crop, rash experiments are to be deprecated, and above all health of the culture should be the main consideration. Phenomenally high yields lasting for short periods only, would be of little use.

Unfortunately our knowledge of the physiology of the rubber tree and the relationship of the latex to the general metabolism of the tree is still small.

At the same time, attention to problems connected with the breeding and selection of improved strains of trees, in respect of yield and other desirable characteristics are not being neglected. It is desirable to emphasize however that work of this nature must be necessarily slow in the case of a plant such as the rubber tree.

Manufacture and Factory Methods :—There has been no radical change in the methods employed for the preparation of lower grades of raw rubber for many years. Any alterations have consisted only of improvements in details in the manufacture of smoked sheet and thin pale crepe, which still constitute the two forms of " first latex " plantation rubber in Malaya.

The natural evolution of the plantation rubber industry combined with the light which has been thrown on the cause of variability in respect of rate of vulcanisation by scientific

research has resulted generally in the manufacture of a much more uniform type of rubber on any individual estate and also from different estates.

Variability :In 1910 the rubber manufacturers' greatest difficulty judged by the statements made at the time was the variability of the plantation product in respect of rate of cure. Those who maintain that too great stress has been laid on this particular problem are possessed with somewhat short memories, although it will be admitted by all that this problem has not now the significance which it had some ten years ago.

Further, the increasing and now extensive use of many organic vulcanisation accelerating agents, more especially in America, has given an entirely new aspect to many problems of the rubber industry. In any consideration of possible future changes in methods of preparation or even in improvements in details in the manufacture of the present types of plantation rubber, due regard must be paid to manufacturers' requirements. In this connection it is desirable therefore, to direct attention to other types of variability met with in the factory at the present time.

Complaints have been made by manufacturers in respect of two other types of variability of the raw material. These consist of a lack of uniformity in the ease of "breaking down" on the hot mixing rolls and in the properties of solutions prepared from the raw rubber.

No investigations have yet been made to ascertain the cause of these types of variability, which are probably connected either with the state of polymerisation of the caoutchouc in the raw rubber or with differences in the amounts and constitution of the so-called "impurities" or non caoutchouc constituents, which are invariably present in the commercial raw product.

Little information appears to be available in technical literature, but conversations with the technical officials in various rubber works has elicited the information that work in this direction is important.

Scientific methods of preparation :—At the present stage of the rubber industry, especially in view of the excess of production over consumption of the raw material, manufacturers' difficulties do not particularly concern the producer and it is extremely doubtful whether any radical improve-

ments effected in the raw material by the application of more scientific methods of preparation or any discovery of a special prosess of preparation resulting in the production of a raw product having special qualities, would have any effect on the value or price of the raw materials.

The price and value of raw rubber, like most other commodities, depend entirely on the laws of supply and demand, and unless any estate or group of estates is in possession of any method of preparation, which produces a raw material having superior qualities and which can be sold direct to the manufacturer, such a process would be of no benefit to the producer under the present market methods of buying and selling.

This is without doubt one of the principal reasons why certain groups of estates, on account of the present need for economy, have dispensed with the services of their scientific officers.

Appearance and quality:—At the present time and for some time past, the principal factor which has any influence on the market value of the raw product is its appearance, irrespective of the intrinsic quality.

While a good appearance undoubtedly indicates care and supervision in preparation, it does not necessarily follow that appearance is correlated with the real quality of the raw material, nor that certain so-called defects are in any way indicative of inferior quality. For example, the defect known by the brokers as "rust" on smoked sheet is certainly not connected with any inferior quality in the raw material, while the treatment of lower-grade rubber such as lump, cup washings and tree scrap with solutions of sodium bisulphite and sulphuric acid in order to obtain a rubber of paler and more even colour undoubtedly lowers the quality, although such rubber obtains a better market price on account of its appearance.

Further, much pale-coloured native sheet, probably prepared by the use of alum, is converted into blanket crepe in Singapore and fetches a higher price than the darker native sheet which is coagulated with acetic acid and which on conversion to blanket crepe has a darker colour. In this case intrinsic quality is certainly not correlated with the appearance. The only point, therefore, which concerns the individual producer at the present time, in connection with the preparation of the raw rubber is the appearance of the

rubber and its valuation by the broker. For some time past, nearly all samples received for investigation have been sent on account of such defects in appearance as bubbles, "rust," streakiness or dullness in crepe, yellow colour of pale crepe, "spot" disease and a few others.

Considerable information is now available in connection with the causes of and remedy for all of these defects. A good superintendent of the estate factory, who is capable of applying advice given in written instructions or in the literature already published, should be capable of dealing with these problems.

It is still unfortunately a fact, however, that the same problems are continually being raised with requests for advise, which appears to indicate that very few planters take the trouble to read information which has been published in connection with these problems.

Present methods :—There is no necessity, as far as the planting public of Malaya is concerned, to give any detailed account of the present methods of preparation of the different grades of plantation rubber, or of the methods of packing, buying or selling, since these are so well-known. Any remarks therefore may be directed to special features which are of importance in the preparation or treatment of the different grades of the raw material.

Coagulation :—With the exception of native sheet, and possibly in the case of one or two large estates, all latex is coagulated with acetic acid, nor does it appear probable that any other coagulant is likely to be substituted. Sulphuric acid is still used by a few estates, but its use has been condemned as undesirable by the Department of Agriculture and more recently by the Rubber Growers' Association. Alum and mixtures containing alum are still being used to a large extent in the Straits Settlements and Johore by small holders and also apparently in the Federated Malay States, in spite of rules prohibiting their employment.

The chief improvement which has taken place during recent years on large estates is the coagulation of latex in bulk in the preparation of both sheet and crepe rubber, which has resulted in much greater uniformity in the raw material. No special recommendations are necessary at the present time in this connection.

Manufacture of Smoked Sheet :—The improvement in the uniformity of smoked sheet, due to the coagulation of latex

of constant concentration in bulk in large divided tanks has without doubt been considerable. The ideal type of tank, particularly in respect of materials used in the construction, has yet to be found, and the preparation of sheet in deep tanks is attended with certain defects, particularly bubbles, which affect its market value, far more than in the case of sheet coagulated by the older method of separate shallow enamelled pans.

Tank coagulation has also necessitated the general use of the anti-coagulant and anti-ferment—sodium sulphite—the chief effect of which is to reduce bubble formation, since the bubbles are produced by fermentation. Bubble formation is greater in tank that in pan coagulation on account of the fact that the coagulation of latex in deep tanks is partially anaerobic, under which conditions bubbles, due to the formation of gas from the decomposition of carbohydrates in the latex, are produced.

Great care must therefore be taken that the tanks do not become "sour" and they should be washed periodically with a dilute solution of formalin and the dividing partitions treated similarly or exposed occasionally to the sun.

Cement tanks, lined with glass and with glass or aluminium partitions are now on the market and would appear to be the most suitable type and preferable to the wooden tanks, or cement tanks lined with glazed tiles with wooden partitions, now commonly in use.

The important points in connection with the preparation of smoked sheet, to which attention should be directed, are elimination of "rust" and ventillation of the smoke house. The elimination of "rust" must be effected, on account of the broker's prejudices, although it does not affect the real quality of the rubber. "Rust" is due to the exudation of the serum products from the interior of the sheet, which evaporate on the surface and usually form a thin film which sometimes give the rubber a wrinkled glossy appearance, especially in the depressions on a "diamond" marked sheet. When the sheet is stretched, the film is broken and appears as a brown rusty deposit. According to some Dutch scientists the film is caused by the bacterial decomposition of the serum products which exude and evaporate on the surface.

One factor which is liable to induce "Rust" formation is the use of a concentrated latex in the preparation of the

sheet, as the serum products which exude will also be concentrated.

Two methods of elimination may be employed. The sheets immediately after machining may be hung on racks to drip, so that much of the watery exudation may drip off, and after an hour or so, the sheets should be washed in running water or in several changes of water before placing in the smoke house. This washes off the serum products which exude from the sheet after machining.

An alternative method is to hang the freshly machined sheets in the sun for a few hours before removing to the smoke house. In regard to smoking, sufficient attention has not been paid in many instances to the ventilation of smoke houses. Ventilation and the use of dry fuel are important and attention should be paid to both.

Manufacture of Pale Crepe :—The manufacture of pale crepe by the use of sodium bisulphite to prevent the normal or natural darkening of the rubber, which is otherwise caused by the action of the oxidising enzyme on certain substances almost invariably present in Hevea latex, calls for no remarks.

Enquiries however are occasionally received in connection with the yellow colour of pale crepe which occurs on some estates or on certain occasions. This colour is almost certainly a natural colouring matter present in the latex, frequently to a much greater extent when new cuts are opened, and does not appear to be connected with the normal darkening caused by oxidising enzymes. It is not reduced by the use of excessive quantities of sodium bisulphite and no method of reducing the colour appears to be known at present.

Manufacture of lower grades :—With the present ratio between production and consumption of rubber and the low market price of rubber, the only lower grade rubber which appears to be worth preparing is that composed of the lump, washings and skimmings and picked tree-scrap, which can be mixed and converted into one grade. A lighter coloured product can be prepared by soaking the fresh material, as soon as possible after collection, in a bath of sodium bisulphite and acetic acid, followed by a similar soaking of the crepe immediately after machining. This will improve the colour and market value, but not quality.

Packing of rubber:—In spite of recommendations and the invention of other suitable methods of packing, the greater part of the rubber in Malaya is still exported in wooden cases and no precautions, such as lining the boxes, are taken to avoid contamination of the rubber with dust and splinters from the cases. For local transport to Singapore however, collapsible canvas cases are employed by some estates and found to be satisfactory and economical.

Two recent inventions consist of cases constructed of a good quality lower grade crepe or of the dried leaves of the "mengkuang." The market objection to such packing appears to be that the rubber in the lower packages, when in the hold of a ship, becomes consolidated to a solid block owing to the weight of the packages above. Apart from this, such packing material would appear to be very satisfactory.

It is however surprising that no attempt has been made to line the inside of the ordinary wooden cases with a good lower-grade crepe or even to place a number of the sheets in the box in such a manner that a rubber lining composed of single sheets is formed, which would protect the whole of the remaining rubber packed in the box. However, the producer can probably scarcely be blamed, since, even if he took this trouble, he would not necessarily obtain a better price for his product.

Future possibilities of manufacture:—It is not possible to forecast any radical changes in the types of "first latex" rubber which may be marketed in the immediate or more distant future. The value of "slab" rubber, on account of its specially rapid vulcanising qualities combined with its generally superior quality as compared with sheet and crepe, is possibly discounted to a great extent by the remarkable increase and extended use of numerous organic vulcanisation accelerators now on the market. A representative of a large American manufacturing company stated recently, at the Department of Agriculture, that Akron, the great modern centre of the rubber manufacturing industry in America, owed its present position largely to the researches which had been carried out in this connection by the American invesitgators in the factories in Akron.

Another statement made by the same gentleman was to the effect that, in his opinion, the washing and crepeing of rubber, such as "slab," in the American factories could probably be effected as cheaply as in the East, on account of

the large size of the washing machines employed, which compensated for the cheaper cost of labour in the tropics. This statement is significant, in view of the fact, which is generally known, that the large American estates in Sumatra, owned by the United States' Rubber Company, still ship the raw product to their own factories in America in this form and wash and crepe the rubber in the American factories. Whatever method of preparation may be adopted in the future, one fact appears certain viz. that the fuel problem in connection with the manufacture of smoked sheet will sooner or later become critical. For the present, all the wood being used for this purpose is derived from old jungle stumps or timber on the estate which it is desirable to clear or from the rubber wood derived from thinning out, but this will not be the case in the future. In the collection of figures obtained on behalf of the Department of Forestry it has been estimated that approximately 220,000 tons of wood were consumed in rubber factories during 1919. These figures are based on the consumption of one ton of wood for every 1085 lbs. of rubber. The consumption of wood may therefore be estimated at rather more than twice the output of rubber.

It would appear advisable therefore to direct serious attention to this problem and to state that in the not distant future some other method of preparation of the raw product will have to be considered, which will eliminate or considerably reduce the large amount of fuel consumed in the smoking. The shortage of wood fuel, apart from its actual cost, may have an important influence on the method of preparation of raw rubber in the future.

Many of the present difficulties of the producer arise owing to a lack of co-operation between the producer, broker, agent and manufacturer.

Oils and Fats.

Fixed Oils and Fats.

Essential Oils.

Notes on Principal Malayan Oils and Fats.

Miscellaneous Oil Yielding Crops.

CHAPTER VI.

Oils and Fats.

OILS and fats occur in all the three kingdoms into which the world's natural products are sometimes divided, the mineral, the vegetable and the animal. It is not proposed to elaborate this method of sub-division as only one of the three is being considered in this article namely the second, or vegetable. Vegetable oils and fats might be preferably termed plant oils and fats, since from a botanical point of view there are few vegetables which yield oils or fats.

There is no necessity to point out the vital importance of the provision of adequate supplies of these oils and fats in the world, in view of the large quantities which are consumed directly or indirectly in the form of edible fats and soaps by each human being in maintaining the body in a clean and healthy state. If one considers also the vast number of other ways in which they are needed in order that mankind may be enabled to maintain its present high state of civilisation, it only serves to emphasise the absolute necessity of each country being assured of sufficient quantities.

Malaya, like all tropical countries is particularly rich in oil bearing plants, only one of which, namely the coconut, has ever been exploited commercially. There is reason however, to believe that with the decline in value of rubber more attention will be paid to the cultivation of oil bearing plants, and that it will be no longer necessary as at present to import large quantities (in the quarter ending September 30th, 1921 oil seeds and oils to the value of about $500,000 were imported).

Further in view of the large demands for such oils by countries situated in the temperate zones and unable by reason of climatic and other conditions to supply all their requirements, which must be supplemented by imports from the tropics, there is no reason why this country should not be able to supply a larger portion of these demands. A large amount of experimental work is necessary before this state of affairs becomes a reality, as the cultivation of oil yielding plants and especially the production of oil demand careful supervision and skilled technique.

Classification :—It is perhaps necessary to state that the difference between an oil and a fat depends solely on temperature, for a fat when melted becomes an oil, and an oil when solidified becomes a fat. An instance of the manner in which the temperature of a climate affects this nomenclature is seen in the case of coconut oil, which in this country is a liquid and would therefore be regarded as an oil, while in Northern Europe it is usually solid and would be regarded as a fat.

The plant oils are classified as " Fixed " and " Essential." By the term " Fixed " is indicated an oil which cannot be volatilised without undergoing chemical decomposition, while the opposite applies to essential oils which are known also as volatile oils.

There is also a vast difference from a chemical point of view. The fixed oils and fats are mixtures of glycerides of fatty acids, that is to say, chemical compounds formed by the combination of glycerine with fatty acids, together with a greater or smaller proportion of free fatty acids, and yield glycerine and soap when treated with caustic alkalis. This free fatty acid content of an oil is an important factor since, as will be seen later, the proportion determines very largely the use to which the oil can be put and consequently its value.

Essential oils consist of mixtures of highly complex organic compounds, hydrocarbons (compounds of carbon and hydrogen) alcohols, aldehydes, esters, etc. which do not react with caustic soda in the same way as the fixed oils.

It is advisable to describe these oils separately, since the methods of extraction and the commercial uses are so distinct.

Fixed Oils. *Occurrence and Extraction:*—Fixed oils are found almost entirely in the seed of plants where together with starch and porteins they serve as foods which would be required by the seed if allowed to germinate. The preparation of the oil therefore resolves itself into an extraction from the seed, which is carried out by two alternative methods, either by the purely mechanical process of submitting the crushed or ground seed to high pressure in special presses or by treating the seed with chemical solvents which will dissolve out the oil only.

It will be realised however that it is only possible in certain cases, notably in the case of small seeds, to extract the oil direct from the seed by one or other of these processes without preliminary treatment. Large seeds and those which have a hard outer shell must undergo a preliminary treatment, either a crushing between rolls to bring them to a fine state of division, or decortication, by which is meant the removal of the outer husk or shell, followed by a crushing between rolls. In the case of the coconut, for example both the fibrous husk and the hard shell have to be removed before the oil is expressed or extracted.

In the case of expression, the small seeds or fine meal are placed in a hydraulic press, from which the oil is forced out and collected. Sometimes the seeds or meal are heated before pressing, in order to reduce the viscosity of the oil to enable it to flow more freely, in which case the oil is termed "hot pressed" or "hot drawn." "Hot pressed" oil is apt to be slightly discoloured or darkened, by colouring matters which may be present in the seed and soluble in the hot oil, and therefore for certain purposes, notably for edible or medicinal purposes, "cold drawn" oil is prepared. The "cold drawing" process usually leaves a considerable amount of oil in the meal or cake, hence it is a common practice to break up the cake left in the press after "cold drawing," and to heat it in order to obtain a further quantity second quality oil by the hot process. If the oil is very viscous or the seed particularly rich in oil, the cake after this second expression may again be broken up, reheated and pressed in which case a third quality oil is obtained.

In the second process the oil is extracted from the seed or the meal by means of hot or cold chemical solvents. The chief solvents in use are carbon bisulphide, benzene, carbon tetrachloride and tri-chlor-ethylene. Briefly, the process consists in allowing the hot or cold solvent to percolate through the seed or meal containing the dissolved oil, transferring it to a heated still in which the solvent is distilled off and condensed and can be used again.

These are not necessarily rival processes and are worked together sometimes in the same factory. Thus, certain seeds can be crushed cold in order to secure a high class edible oil, and then treated by the solvent extraction process to recover the remainder of the oil, since with the solvent extraction process it is poossible to obtain 99 per cent efficiency, whereas it is hardly possible to extract more than 90 per cent of the total oil content of seed by pressure alone.

Application and uses :—It would be difficult to enumerate all the uses of oils, but among the chief are the applications which they find in the manufacture of butter substitutes (margarine) and other preparations for edible purposes, soaps and candles, paints and varnishes, linoleum, leather and lubricants. In all these applications, except in the case of soap and candles, the oil must be relatively free from an excess of free fatty acids ; otherwise it must undergo a preliminary refining process or be utilised as soap or candle stock, in which case the presence of free fatty acid makes little difference. Soaps consist chiefly of sodium and potassium salts of fatty acids and are made equally well by treating either the oil or the fatty acids with caustic potash, while candles are to a large extent composed of free fatty acids.

The oil cake or meal remaining after extraction constitutes a valuable bye-product, either as cattle food or fertiliser. It is more profitable to use this residue as cattle food and to return it ultimately to the soil in the form of cattle manure. In the case of some seeds (e.g. castor oil seed) this is impossible, as the meal or cake contains some poisonous substance, and therefore can only be utilised directly as a fertiliser.

Essential Oils. *Occurrence and Extraction :*—Unlike fixed oils which occur almost entirely in the seed or fruit, essential oils may be found in various parts of the plant, the leaves, the roots, the flowers, the bark, and the seed or fruit, for example in the case of the rose the oil is obtained from

the flower petals, while in lemon grass the oil is present only in the leaves. Nutmegs contain both fixed and essential oils. Frequently too, more than one essential oil occurs in a plant thus in the case of the cinnamon tree, the bark, the leaves and the roots all yield different oils.

Essential oils occur in plants in very small quantities, it is seldom that the yield of oil culculated on the weight of fresh material exceeds three to four per cent, frequently it is less than one per cent.

The essential oils may be extracted by four different methods :—

(1) Distillation with steam, steam being generated apart from the distillation apparatus.

(2) Distillation with steam, the water and plant material being boiled together in the same container.

(3) Extraction with volatile solvents such as potroleum ether.

(4) Extraction with non-volatile solvents with or without the aid of heat, such as animal fat, known as enfluerage.

It is not proposed to discuss the last two methods as it would not be possible at present to apply them conveniently in this country and, in the case of the first two, only a general description need be given which covers both, except in the minor detail of the raising of the steam.

It has been pointed out that essential oils are also known as volatile, or in other words that the oil is continually vaporising. The volatility of an essential oil increases with the temperature, provided the latter is kept below the point of decomposition, hence the employment of steam as an agent to increase the volatility and at the same time to ensure that there is no decomposition.

The plant material which contains the oil is placed in a boiler provided with a pipe leading to a condenser; steam is injected, thereby volatilising the oil ; the mixture of oil and steam is condensed and collected in suitable vessels, the oil, not being miscible rising to the surface or sinking to the bottom according to its density.

Application and Uses :—These oils are used chiefly as perfumes, flavourings for food and drinks, and in medicines, in the last case either as specific drugs, or as flavourings to render a medicine more palatable. It will be readily understood that except for those of medicinal value, these oils are in reality luxuries and not necessities as in the case of the fixed oils.

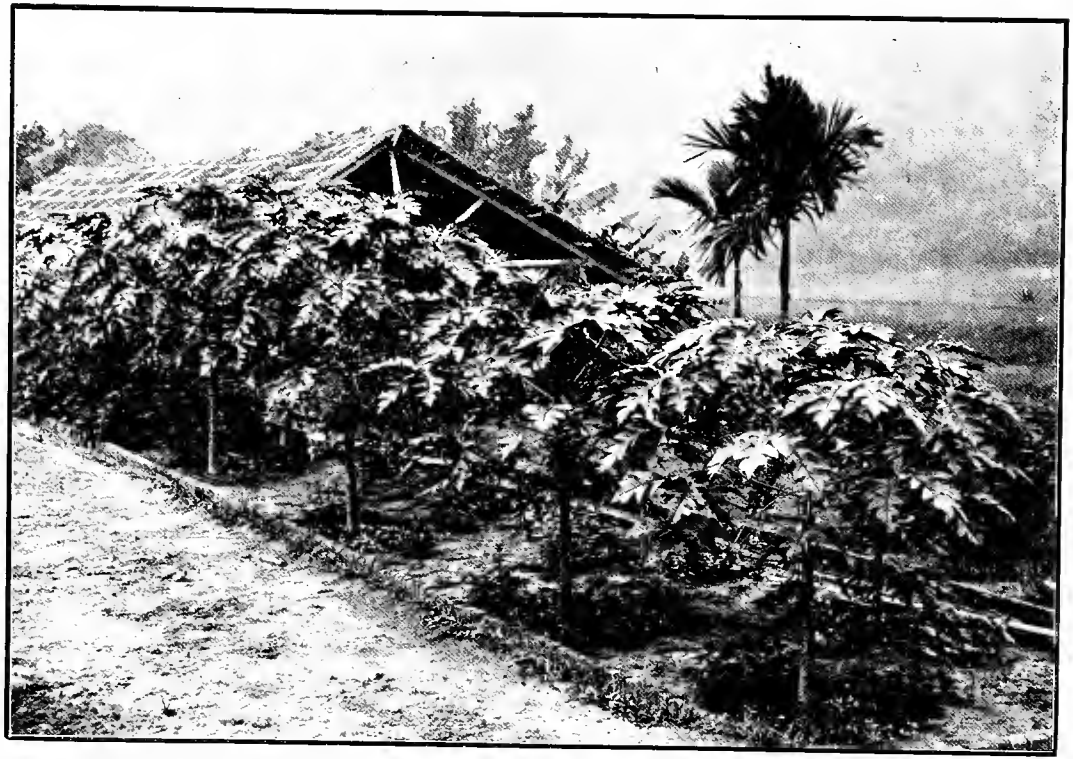
Having explained very briefly the general classification of these oils and the principles underlying their extraction, certain of the more important ones which can be cultivated in this country will now be enumerated, together with special remarks in regard to their preliminary treatment, extraction, etc.

Fixed Oils.

Coconut Oil :—The preliminary treatment of copra is so well known as to need no description, except to point out that, unless the moisture content is reduced and kept as low as possible, there will be a large increase in the amount of free fatty acid in the resultant oil. Special disintegrating machines are also required in order to reduce copra to a fine state of division preparatory to the expression of the oil, which is usually carried out twice on account of the high oil content.

Palm Oil and Palm Kernel Oil :—The African Oil Palm fruit contains two distinct oils, namely Palm Oil, present in the flesh or pericarp, and Palm Kernel Oil contained in the kernel. The treatment of these fruits also calls for special attention as there is present in the pericarp a very active fat-splitting enzyme or non-organised ferment. It is of the utmost importance that the fruit be picked when ripe and treated when fresh, otherwise a large portion of the oil will be decomposed with the formation of an abnormal proportion of free fatty acids. With moderate care this acidity can be easily kept below five per cent, but if the fruit be allowed to lie about and the oil is extracted in the primitive native way by boiling out with water, the oil may contain up to fifty or sixty per cent free fatty acid.

The most recent method adopted to obtain palm oil of high quality consists in a preliminary heating of the fruit to destroy the ferment and subsequent pressing while still hot to obtain as much of the oil as possible, without cracking the nut. The pericarp is then stripped from the nuts in a special machine known as a depulper or depericarper and pressed



YOUNG PAPAYA TREES WITH PATCHOULI GROWING BELOW
at the Experimental Plantation, Kuala Lumpur

COLLECTING POLLEN FROM OIL PALMS
in the field

OIL PALM
four months after artificial pollination

again, to obtain a second quality oil. The residue is used as fuel, having no value as a feeding stuff or fertiliser.

The nuts have to be cracked to obtain the palm kernel oil. This is carried out in a special machine, the kernels are then separated, ground as in the case of copra and hot-pressed ; the last operation is carried out twice on account of the high oil content of the kernels.

Castor Oil :—The preliminary treatment of castor oil seeds does not call for any special remarks, except that the crushing must not be too severe, as the seed is very soft. If medicinal oil is required the seed must be cold-pressed, otherwise a poisonous constituent present in the seed will pass into the oil. On account of the high viscosity of the oil, only a relatively small percentage of the total oil content can be expressed in the cold, hence the cold-pressed meal is subjected to a slow hot-pressing to obtain a further quantity of oil which is suitable for lubrication and other purposes. The meal or cake from castor seed is poisonous and can therefore be used only as a fertiliser.

Candle Nut Oil :—The kernel of the candle nut is enclosed in a very hard shell, which constitutes nearly seventy per cent by weight of the nut, and must be cracked as in the case of palm nuts. The oil is readily expressed from the kernels as the latter are very soft. The meal left after pressing if poisonous and can therefore be used only as a fertiliser.

Rubber Seed Oil:—Rubber seeds contain between forty two and forty five per cent of husk and are preferably decorticated before pressing, which is carried out hot. This seed also contains an active fat-splitting enzyme and consequently, to obtain a high grade oil, the seeds should be pressed as soon as possible after collection or must be treated in some manner to prevent the decomposition of the oil.

Ground Nut Oil :—The expression of ground nut oil from the shelled nut calls for no special comment, except that, being an edible oil, the nuts are always first cold pressed.

Gingelly Oil :—The expression of oil from gingelly seeds can be carried out without preliminary treatment being first cold pressed to obtain an edible oil and subsequently hot pressed.

Essential Oils.

Citronella Oil :—The extraction of citronella oil is carried out by means of the steam distillation method already described. The grass is cut up into short lengths, and placed in boiler through which steam is blown ; the mixed vapours of oil and water are condensed, and the oil, being lighter than the water, rises to the surface and can be easily separated from the water.

The grass should be fresh when distilled, or if this is not possible, care must be taken to ensure that it is not allowed to become heated during the intervening period, otherwise both the quality and quantity of the oil will be affected. The yield of oil is greatest from young grass, and may be as high as 0.8 per cent, while with old grass the yield may be as low as 0.3 per cent.

Lemon Grass Oil :—The extraction of lemon grass oil is carried out in a similar way to citronella oil. The normal yield of oil is much lower, rarely exceeding 0.3 per cent calculated on the weight of the fresh grass.

Patchouli Oil :—Patchouli oil is distilled from the dry leaves of the patchouli plant. The leaves must be carefully plucked and dried in order to obtain the maximum yield of oil. The oil has a very delicate but persistent odour and is highly esteemed in perfumery.

The above list does not exhaust the oil-producing plants which can be cultivated in Malaya ; the exhibits will show that there are many others, for which at present there is either no demand or the cultivation of which has not been taken up to any extent. They are therefore only of scientific interest at present.

Machinery for Oil Extraction :—A detailed description of the various types of machinery suitable for the expression or extraction of the fixed oils and fats from seeds would occupy too much space here. Such details and details in respect of special machines required for the preliminery treatment of palm fruits and palm nuts can be obtained on application to the Department of Agriculture. Further information in regard to such machines will be published shortly in the Agricultural Bulletin.

Conclusions :—From the foregoing remarks it will be seen that a large variety of oil bearing plants many of which

have important commercial uses can be cultivated in Malaya. In many cases too, these oils constitute necessities of life, and therefore, while their prices are never likely to rise to such an extent as will produce the return on capital which has been obtained on other commodities, their production in sufficient quantity should be encouraged, and they should be regarded more in the light of a valuable national asset which if properly looked after will ensure prosperity in the future.

The oil content of the different raw materials, the uses of the oils and the present market prices are shown in the table which follows :—

Table giving details regarding some of the more important Plant Oils of Malaya.

Name of Oil.	Botanical Name of Plant.	Oil content of seed etc.	Use of Oil.	Present Price.
		FIXED OILS.		
Coconut Oil	Cocos nucifera	65 to 70% on copra	Margarine, edible purposes, soaps and candles	£45—£50 per ton
Palm Oil	Elaeis guinensis	50 to 55 per cent on the pericar equivalent to about 30—35% on the fruit	Soaps, candles (1) and lubricants	£30—£35 „
Palm Kernel Oil	Elaeis guinensis	45 to 50% on the kernel equivalent to about 20% on nuts	Margarine, edible purposes, soaps and candles	£40—£42 „
Castor Oil	Ricinus communis	40 to 50% on the seed	Soaps, lubricants, dyeing industry, leather and medicinal	£50—£55 „
Candle Nut Oil	Aleurites triloba (Synmolnccana)	62% on the kernal equivalent to about 19% on the nut	Paints, varnishes, soaps	£25—£28 „ approximately (2)
Rubber Seed Oil	Hevea brasiliensis	42% on the kernal equivalent to about 24% on the seed	Paints, varnishes, soaps	£20 per ton approximately (2)
Grounnd Nut Oil	Arachis hypogaea	43 to 48% on the seed	Edible, soaps and burning	£46—£48 per ton
Gingelly Oil	Sesamum indicum	45 to 53% on the seed	Edible, soaps and burning	£45—£50 „
		ESSENTIAL OILS.		
Citronella Oil	Cymbopogon nardus	0.3 to 0.8%	Cheap perfumes, used specially for scenting soaps, mosquito preventive	2/6 per lb.
Lemon Grass Oil	Cymbopogon citratus	0.15 to 0.3%	Perfumes, specially artificial oil of violets	3*d* per oz.
Patchouli Oil	Pogostemon cablin	0.4 to 1%	Perfumes	45/- per lb.

1. The first grade palm oil manufactured as described in the text can be used for margarine and edible purposes, like coconut and palm kernel oil.
2. No actual figures available.

Coconuts. *(Cocos Nucifera.)*

The coconut is the second important crop of the Malay Peninsula.

Distribution :—The coconut thrives well throughout the whole Peninsula and large areas are cultivated in Penang, Province Wellesley, Krian, the Dindings, Bagan Datoh in Lower Perak, in Selangor along the coast from the Bernam River to Sepang, in the southern part of Johore and on the East coast of Johore and Pahang. There is no doubt that the climate of this country is suited to the growth of coconuts, both as regards temperature and rainfall.

The natural habitat of the coconut is near the seashore and the coastal districts are recognised as the most suitable for its growth. Such land is generally flat and usually provided with natural outlets and sufficient fall to allow of thorough drainage. The soil is mostly alluvial and palms grown under such conditions commence flowering in their third or fourth year. Coconuts can however be profitably grown in the inland districts, but they take longer to reach the producing stage.

Copra :—The following figures show the exports of copra from the Federated Malay States for the last three years :—

	Quantities Pikuls.	*Value* $
1918	428,225	3,053,325
1919	447,717	5,146,575
1920	419,988	9,216,586

The greater part was exported to Penang and Singapore, where large quantities of copra are taken for re-export to other countries.

The exports of copra from the Straits Settlements (Singapore and Penang) in 1919 are given as 1,912,647 pikuls valued at $33,776,114 and in 1920 as 1,994,098 pikuls valued $45,753,153. The principal countries to which the exports of copra were made are the United Kingdom, France, Denmark, Belgium, Italy and the United States of America.

It is interesting to note that the exports to Denmark increased from 476,902 pikuls in 1919 to 854,037 pikuls in

1920, the following table shows the comperative value of exports in the last two years to the United Kingdom, France and Denmark.

	United Kingdom.	*France.*	*Denmark.*
1919	10,112,445	9,375,961	8,141,667
1920	5,649,542	5,880,557	19,578,613

The above figures show that there was a large reduction in the value of exports to the United Kingdom and France 1920 compared with 1919, but that exports to Denmark were more than doubled for the same period.

Coconut Oil:—The production of coconut oil in Singapore, where there are several oil mills engaged in this industry, is fairly considerable, the exports in 1920 being valued at $5,786,569 against $6,039,195 in 1919.

Although a quantity is shipped to the United Kingdom, the principal countries to which the oil is exported are Sumatra, the Federated Malay States, Siam, Java and Borneo, where it is consumed by the Asiatic population.

In addition to the imports from Singapore a certain quantity of oil is both manufactured and consumed in the Federated Malay States.

Coconuts:—In addition to the export trade in copra and coconut oil, fairly large quantities of whole coconuts are exported from the Straits Settlements and the value of such nuts shipped from Penang and Singapore in 1919 and 1920 were $279,600 and $463,650 respectively. There is also a somewhat extensive local trade in both the Federated and Non-Federated Malay States in fresh nuts, which are used principally for food, and a large proportion of the produce of the native holdings is absorbed in this way.

Cultivation:—The most suitable soil for coconut cultivation is an alluvial loam, but some of the stiff clays, when properly drained, also produce excellent crops. When the area to be opened up is low-lying, as is common in the coastal districts, rentices are first made through the jungle and the main drains cut immediately, in order to dry the land as much as possible before felling is commenced. The next operation is to lay down the nursery. Nuts for seed should be gathered from well-matured palms, between fifteen and

forty years old, which are known to be good yielders. The nuts should be fully mature before being picked from the tree and allowed to dry for one to two months after they are picked in order to harden the husk. Nursery beds, about four feet wide, should be carefully prepared with good soil and slightly raised to permit of efficient drainage. A thin layer of sand on the surface of the beds is beneficial as it prevents the ground becoming too damp and causing the roots to rot. When the beds are ready, the seed nuts should be placed on the ground in rows about two feet apart, partly buried and in an oblique position with the acute end of the nut downwards. The seed beds are sometimes shaded for a time, but the shade should be gradually removed and the plant fully exposed before it is ready for planting in the field. The best age at which to remove seedlings from the nursery for transplanting in the field is from five to seven months. If left in the nursery longer, the difficulty of transplanting is greater and the roots are liable to get damaged.

After felling and burning operations are finished the land is throughly cleaned up and prepared for planting. The best distance of planting in the field is 30 ft. x 30 ft., which gives 48 trees per acre. The area to be planted should be carefully lined and holed ready for planting. The holes which are usually made two feet wide and two feet deep, are filled up with good surface soil and the seedling planted so that the top of the nut, where it starts to germinate, is just above the level of the surface, deep planting is usually disastrous.

The most critical time for a palm is during the early stages of its life, that is, from the time of planting to the third or fourth year, and it is only by careful attention during this period that early matured and good bearing trees are likely to result. After planting, the ground around the young palms should be clean weeded and no grass or other noxious weeds of any kind should be allowed to interfere with their growth. To develope the feeding roots the surface soil at the base of the palm should be kept in a friable condition by digging or forking at least every three or four months.

As an alternative to clean weeding, leguminous cover crops may be established in the first year of growth, which will reduce the cost of weeding, and at the same time increase the fertility of the soil. When the young plants begin to develope, growth may be further improved by surface cultivation with ploughs or disc harrows. On peaty land, where the soil is apt to subside after it is opened up, mound-

ing or banking the young plants is often necessary, and this operation may have to be continued until the land has settled down to its normal level. On low-lying land drainage operations will have to be carried out as the coconut will not thrive in a water-logged soil. The palm is fairly free from the attacks of insect pests and diseases. The worst pests are the red-stripe weevil *(Rhyncophorus Sach),* the black beetle *Oryctes rhinoceros)* and the caterpillar of a moth *Brachartona catoxantha,* whilst the chief diseases are sporadic cases of bud-rot and the leaf spot caused by *Pestillozzia palmarum.*

Yields:—The coconut usually comes into bearing between the fourth and sixth year after planting and may continue to bear good crops of fruit for sixty years or more. When the trees come into bearing the ripe nuts are collected every two to two and half months, which gives five to six pickings during the year. A good palm in full bearing will yield as many as 80 to 100 nuts but the average is about 50 nuts per palm per annum, or roughly 2,500 nuts per acre per annum.

Nuts for making copra should be collected when they are fully ripe as unripe nuts are useless for this purpose. After harvesting, the nuts should be allowed to remain unhusked for about two weeks ; the fibrous husk is then removed, the nuts split open with a sharp knife, and the kernel or meat removed from the shell, and dried in the sun or placed in special kilns and artificially dried. The latter is both a quicker and a cleaner method of drying. Usually from 230 to 250 nuts are required to produce a pikul of copra, which is equivalent to about 4,000 nuts to a ton of copra. The kernel is very rich in oil and good copra will yield as much as 64 per cent of coconut oil by the ordinary method of expression in hydraulic presses.

The Dwarf Coconut:—The Dwarf or King Coconut, which is known locally as "Nyiur Gading," has recently been attracting considerable attention as a possible new enterprise. Only one estate has so far attempted the cultivation of the dwarf variety on a large scale, and it is .still doubtful whether the results obtained justify the returns which are expected or even bear comparison with those of the commonly cultivated tall variety.

The dwarf variety is usually planted 22 ft x 22 ft, giving 90 trees per acre, and comes into bearing at about the third year after planting. The average yield at six years is stated to be 80 nuts per palm per annum. The nut is smaller and

the kernel thinner than that of the ordinary variety, with the result that on an average 500 nuts are required to produce a pikul of copra.

The chief advantages of the dwarf coconut are that it is hardy, matures early and is very prolific, but its main drawback is the small size of the fruit ; this necessitates the handling of about twice the number of nuts per pikul of copra as compared with the common tall variety,

Uses :—The oil, which is obtained from the dried kernel, (copra) is edible and used largely in the manufacture of margarine. Inferior qualities are also used in the making of soaps and candles. Large quantities of coconut oil are consumed by the Asiatic population for cooking, toilet purposes and as an illuminant. The residue obtained after the oil has been expressed is frequently known as "Poonac," and is commonly used as a food for cattle. Coir ropes, mats, brooms and brushes may be made from the fibre obtained from the husk ; but in Malaya at present the husk is either burnt as fuel for the copra kiln drier or returned to rot in the soil. Alcohol can also be produced by fermenting the sap which is obtained by cutting periodically the unopened flower spathe of the coconut palm and collecting the liquor which exudes in vessels placed on the end of the newly cut spathe. This fermented liquor, as is well known, is the favourite beverage of the Tamil coolie in Malaya.

General :—The cultivation of the coconut under suitable conditions can be safely expected to give steady, though small, returns and with good management, a profit of ten or even twenty per cent on the capital outlay involved is possible with copra at about $12/- per pikul. The present market price of copra in Singapore (January, 1922) is quoted at $10/50 per pikul whilst the latest London quotations of oil are from £45 to £50 per ton, from £27 to £28 per ton for copra, and from £8 to £8-10 per ton for copra cake (poonac).

The African Oil Palm *(Elaeis guineensis)*

The African Oil Palm, the fruit of which yields the two well known oils, palm oil and palm kernel oil, has only received serious consideration as a plantation proposition in the East Indies during the last ten years. Prior to this, little notice had been taken of the palm as a possible crop, though the Dutch East Indian Government had made experimental plantings with considerable success as far as the growth of the palms was concerned.

The cost of factories for the preparation of palm oil is relatively high and, for this reason it is considered advisable to plant large areas of oil palms exclusively, to economize in factory costs. In the Dutch East Indies, oil palm culture is limited almost entirely to Sumatra, where large areas of suitable land are available. According to Dr. Rutgers, the planted area on the east coast of Sumatra is about 25,000 acres, of which 10,000 acres are in bearing, It is likely that this area will be considerably increased in the near future. In the Malay Peninsula, less progress has been made but considerable interest is now being taken in the possibilities of this crop and a number of applications have been made for large areas of land for oil palm cultivation. The financial position during the year 1921 was however not conducive to much progress in actual opening up. Where planting has been undertaken, very satisfactory results are being obtained. The palms on Tennamaram Estate, Batang Berjuntai, where 1,200 acres are planted, compare favourably with palms of equal age in Sumatra.

The question of factories for the preparation of high-grade palm oil on a large scale is at present a difficult one, both in this country and in Sumatra. Provided this important matter can be solved, there appears to be a great future for oil palm culture in the East. The demand for edible fats is steady and high-grade palm oil as well as the palm kernel oil can assist in supplying the world's requirements.

Cultivation:—Considerable information on the cultivation of the oil palm has been published in the *Agricultural Bulletin, F. M. S.* A report on the African Oil palm in Sumatra was issued in 1921 by the Federated Malay States Government as Council Paper No. 32 of that year, and this report has been re-published in the *Agricultural Bulletin,* Vol. IX, No. 2.

Varieties:—The "Deli" type, as in general cultivation in Sumatra and this country, is an exceedingly good one and it is doubtful whether it will be superseded by other varieties introduced from West Africa. Improvement may be brought about by selection from existing palms.

Soil conditions:—The oil palm will grow on almost any soils in Malaya provided they are not swampy. The best results are to be expected from alluvial lands rich in humus that permit of easy root penetration and retention of moisture. There are many large areas of virgin land in this country that are likely to be suitable.

Propagation:—The time that the seed takes to germinate varies according to the age and treatment of the seed. Local seed commences to sprout in three months. Old seed, or those imported from West Africa will take considerably longer.

The most satisfactory method of germinating the seeds consists in sowing them thickly in pure sand-beds, exposed to the full sun and kept in a moist condition by constant watering. Immediately the two leaf-sheaths appear, the seedlings are lifted and planted out about 18 inches apart on good flat land, where they remain until ready for transplanting in the field. The seedling palms are in a fit condition for transplanting when a year old.

Distance of planting:—A satisfactory planting distance is 30 feet by 30 feet triangular (equilateral) thus allowing 55 palms to the acre.

Transplanting and subsequent treatment:—The methods adopted in coconut cultivation may be employed in the case of oil palms. The oil palm stands transplanting well and, with care, little supplying is necessary; immediately after planting, a suitable cover crop should be established on the land. For this purpose the Giant Mimosa (*Mimosa invisa*) is recommended. It is considered inadvisable to cultivate catch crops. No pruning is necessary until the palms come into bearing, which is usually in the fourth year from planting. The leaves below the growing bunches of fruit should not be removed until the fruit is almost ripe and ready for removal.

Pollination:—Experiments in connection with artificial pollination are being conducted at the Kuala Lumpur Government Plantation. Preliminary results show that considerably higher yields may be obtained by this means, though it remains questionable to what extent this may be carried. It appears possible that if every female spadix is pollinated, the palm may become exhausted and the bunches fail to ripen.

Yields:—Reliable records are not available in this country, but the following yields, compiled from information obtained in Sumatra, are considered a fair estimate of what may be expected in Malaya, in the case of palms planted 55 to the acre.

Year in Bearing.	*Cleaned fruit per acre, per annum.*
1	1.1 tons.
2	1.2 „
3	1.4 „
4	1.5 „
5	1.7 „
6	2.1 „
7	2.5 „
8	3.3 „
9	3.5 „
10	4.0 „

Beyong this age it is not possible to estimate with any degree of accuracy. The production in Sumatra is considerably higher than in West Africa in respect of both fruit and oil. As far as can be ascertained, the yield of palms on good land in this country is similar to that obtained in Sumatra.

Harvesting:—On large properties it is necessary to lay down a system of rails for the rapid and economical transport of fruit to the factory. Young palms that have received attention by pruning do not present very great difficulties with regard to harvesting the crop, as the bunches are readily accessible and may be detached easily from the palms with the aid of hatchets. As the palms grow tall it becomes necessary for the coolies employed in collecting the fruit to use bamboo ladders to ascend the palms.

Miscellaneous Oil—Yielding Crops.

Castor Oil Plant. *(Ricinus communis):*—For the cultivation of the Castor oil plant it is desirable to have the land free from all weeds previous to sowing, and to maintain the ground clean, by monthly weeding, for the first three to four months; subsequent weeding is not so important, less expensive, and can be done at longer intervals. The plant thrives quite well on average soil but a rich friable soil is recommended. Good results have been obtained also on peaty land. It does not grow well on light laterite soils or on those which have suffered, to any extent, from surface wash. It flourishes best in well-drained alluvial loams. It is an exhaustive crop and requires considerable preparatory cultivation before sowing.

The plant requires a fair amount of moisture, and rainfall after sowing is essential but, when the plants are

established, their growth may be restricted by excessive rainfall, which is probably one of the reasons why it has not been grown on a more extensive scale in Malaya.

There are several varieties of castor but they are usually grouped under two forms, large-seeded kinds yielding an inferior oil suitable for lubricating purposes, and small-seeded varieties from which the medicinal oil is obtained. The varieties differ in the height of the plant, in colour and size of leaf, stem, fruit and seed.

Considerable attention was given to the cultivation of the castor oil plant towards the latter stages of the war owing to its suitability as a lubricant for aeroplane engines and cultivation was revived in the southern states of America which were once large producing centres until the industry became of uneconomic on account of cheaper production in India. Owing to the importation of unsuitable seed, badly infected with disease etc, it is understood that the attempt to revive the cultivation in American was a disastrous failure, which brought considerable opprobrium on the U. S. A. Bureau of Agriculture. Whether Malaya can compete with India remains to be seen.

Propagation.—The plant is propagated by seed and the latter should be soaked in warm water for 24 hours previous to sowing. The usual method of planting is from four to six feet apart for the small seeded varieties, and up to nine feet apart for the larger ones; from five to ten lbs. of seed is required per acre.

The seeds should be planted either in pairs, or in threes forming a triangle, and about one inch deep, Germination takes place in about ten days and when the seedlings are about 4 inches high the weakest plants should be thinned out. A little pruning may be necessary to encourage the plants to assume a spreading bushy habit and it is advisable to break off the main bud when the plants are about 3 feet high. During growth the land should receive a little shallow cultivation and be kept free from weeds, care being taken not to injure the roots.

Harvesting. Five months after sowing, the capsules will begin to form and hand-picking is carried out from the 6th to the 10th month. When ripe the capsules are very apt to burst open and scatter the seed to a considerable distance and therefore they should not be allowed to remain too long

on the plant, otherwise seed will be lost. Owing to irregular ripening of the the crop, harvesting is somewhat tedious and expensive. The heads should be collected when green but with a few of the capsules turning brown.

The fruits are collected, taken to the store, heaped and covered with straw or sacks. After six days the capsules soften and the shells decay when they should be exposed to the sun for two or three days for the shells to dry and open, precaution being taken to prevent loss of seed when bursting. After sun-drying, the shells are separated from the seed by hand labour, any capsules unopened may either be placed in the sun again, beaten with sticks, or put through light rollers. The seeds are then ready for the market or for expression of oil.

The castor oil plant may be grown as a catch-crop in rubber clearings up to 2½ years old, where the distance of planting is 30 by 30 feet it may be cultivated until the rubber trees are about 3½ years old.

As a catch crop there is little doubt that castor can be profitably grown, but it is questionable whether it will prove commercially profitable as a sole crop. There is a big demand for the oil as a lubricant for heavy machinery and a smaller demand for medicinal and other purposes, but it would be difficult at first for Malaya to compete in the world's markets. There is however, a fair local demand, and in this direction special mention might be made of the F.M.S. Railways. Cultivation of the crop for local consumption should be a sound and profitable proposition.

After cropping, the plants are cut down to within two feet of the soil when another crop of seed is produced though usually of inferior quality ; if pruned close to the ground the plants die. Replanting by seed is recommended in preference to pruning. The yield per acre as a pure crop may vary from 500 lbs. to 1,000 lbs. but definite figures for large areas in this country are not available.

Castor seed contains from forty two to fifty per cent of oil and thirty per cent has been obtained by local methods of expression.

Estimated cost of cultivation as a sole crop.

Light changkolling of the land ...	$6.00 per acre.	
Cost of seed	0.80 „	„
Cost of sowing	1.20 „	„
Cost of weeding 1st month ...	2.00 „	„
Cost of weeding 2nd month ...	2.00 „	„
Cost of weeding 3rd to 5th month ($1/- per acre)	3.00 „	„
Cost of weeding 6th to 12th month ($0.50 per acre)	3.50 „	„
Cost of collecting heads, separating and drying seed ...	8.00 „	„
Total ...	$26.50 „	„

Estimated cost of producing a crop of 750 lbs. of seed = $26.50 per acre, or approximately $4.00 per cwt. This quantity of seed yields approximately 30 gallons of oil.

Manufacture of the oil :—The following four methods of extracting the oil on a small scale are practised by Asiatics. (1) The seeds are crushed between horizontal rollers and the resulting pulp treated in gunnies in a screw-press. The cold-drawn oil thus obtained amounts to thirty six per cent (2) The seeds are roasted, pounded in a mortar and placed in four times their volume of water which is kept boiling. The mixture is constantly stirred, and the oil skimmed off as it rises to the surface. (3) The seed is first boiled, dried for two or three days, then pounded in a mortar and placed in four times its volume of water which is kept boiling, and the oil skimmed off as in (2). Lastly (4) the seed is soaked overnight in water, ground in the morning in a gunny, and then squeezed within cloth till the oil has been obtained. It is generally stated that cold-drawing, with proper machinery, is the best and most profitable method. The kernels are pressed in gunny bags and the oil is thereafter bleached by exposure to the sun, which causes a sediment to precipitate. The oil is then filtered through vegetable charcoal and flannel bags.

On a large commercial scale the seeds are ground and crushed in the usual hydraulic oil expression plant employed for many kinds of oil seeds. The Anderson Oil Expeller or other type of Expeller is recommended in Malaya.

Ground-Nut. *(Arachis hypogaea)* :—The ground-nut plant is an annual herbaceous plant. The flowers, which are small and bright yellow are borne on the end of a long peduncle, which, after fertilization, elongates and forces the immature pod into the soil where eventually it ripens. The fruit pod is straw coloured, about one and a half inches long, and contains from one to four seeds, varying in size and colour, but usually pinkish white.

Varieties:—The common ground-nut sold in the local markets is small and of the Spanish type. There are several varieties cultivated in other countries which produce larger nuts, more suitable for eating, but often yielding smaller crops as compared with the small Spanish ground-nut. These large-podded varieties should be introduced here for cultivation as green manure. Two such varieties, extensively grown for the market in America, are Virginia Bunch and Virginia Runner.

Cultivation:—The ground-nut requires a light sandy soil, well drained but not dry. Land that is liable to become compact or baked is unsuitable on account of the pod stems being unable to penetrate the soil. A dressing of quick-lime should be applied previous to planting the first crop; this has been proved by local experience to increase the yield of nuts considerably and to improve the conditions necessary for nodule formation on the roots.

One of the principal factors in the growing of this crop is the time of harvesting. Planting must be done during wet weather but at such a time that the plants reach maturity during a dry period. A good yield will not be obtained should the crop be lifted during the wet season; the seed at such a time does not ripen properly and is very subject to rot. Previous to sowing, the land should be changkolled or forked to a depth of from 4 to 6 inches; if the land be more deeply cultivated the nuts are liable to be formed at a greater depth and thus the cost of lifting is increased.

Planting:—The nuts are shelled and the seed sown at distances of eighteen inches apart each way. Planting on ridges is to be recommended, as a more reliable and constant crop is obtained, and the nuts are less subject to rot. Little after—cultivation is required beyond surface-weeding, and this must be carefully done so as not to interfere with the nuts, which are near the surface. The crop matures in three to five months, according to variety grown and nature of soil. The nuts are collected when the leaves begin to

wither and must be well sun-dried before being stored. After harvesting, the roots should be left in the ground as the nodules contain nitrogen; the leaves and stems are also returned te the land. Large quantities of ground nuts are expressed for oil in Marseilles and a small quantity of oil is expressed in this country, chiefly from seeds imported from Sumatra.

Gingelly. *(Sesamum indicum) :*—The gingelly plant is an annual two to three feet high, indigenous to Ceylon, South India, and tropical Africa. It is cultivated for the oil which is expressed from the seeds; the poonac (cake) from the seed after the oil is expressed is used as a food for bullocks and also as a fertilizer.

Planting and cultivation :—The plant will grow on any moderately good soil. The land is clean-weeded and changkolled to the depth of four inches and worked up to a fine tilth.

The seeds are mixed with sand and sown broadcast. Sowing takes place during the wet season, at such a time that the crop is ready for harvest in the dry season: the period of growth being from two and half to four months, according to the variety sown.

The plants are cut off close to the ground, when the fruits are about three quarters ripe. They are then laid on the ground and the fruits beaten off. The oil can be expressed by the native wooden press, driven by bullocks or by machinery. (1) The former primitive method of expression is very commonly seen in Malaya. The yield per acre is about 200 gantangs of seed, yielding about 40 per cent by weight of oil

Gingelly may be grown as a catch crop amongst young rubber or coconuts.

The oil resembles almond oil and is extensively used for cooking and medicinal purposes throughout India, Ceylon and the Malay Peninsula.

ESSENTIAL OILS.

Patchouli. *(Pogostemon patchouli.) :*—Patchouli is a soft leaved herb from two to three feet high, much branched, with square stems emitting when rubbed, the characteristic smell of Patchouli. The Chinese, who chiefly cultivate this plant in Malaya, often plant it on newly

(1) The "Cheku," see frontispiece.

cleared ground among the fallen logs. Here, slightly shaded, it grows very rapidly and well. Where it is cultivated regularly, it is planted in properly prepared beds. The leaf constitutes the crop.

Propagation. The best method of propagation is by cuttings of young shoots, These are cut about three inches long, care being taken to cut just below a joint. The cuttings are then pricked into nursery beds, well watered and shaded. In from three to four weeks they will have rooted and can be removed to the permanent beds, where they should be shaded until throughly established. The plant grows well in open sun, but it will also stand a little shade and may be grown as a catch crop in young rubber or coconut clearings. The cuttings may be planted at distances of about two feet.

Crops. The first crop can be cut six months after planting and afterwards twice a year. In Perak, it is usual to take only three crops and then replant. The leaves, after cutting, may be dried in the sun, but it is perferable to dry them in shade, spreading them out in a cool airy shed. When quite dry (after about one week) they may be packed in bales.

One pikul of the leaf dried just as harvested (i. e. with stalks) yields from 24 to 30 ozs. of essential oil and samples free from heavier stalks yield about double that amount.

The yield of good leaf after drying and picking over is estimated at about 1,400 lbs. per acre.

The dried leaf is exported from this country principally to Marseilles and New York. Exports from Penang in 1916 were almost exclusively to New York and amounted to about 65 tons. Messrs. Tiang Joo & Co, 117, Beach Street, Penang are the principal dealers in this product.

The oil was formerly distilled from the leaves in Malaya but the distillation is no longer a local industry.

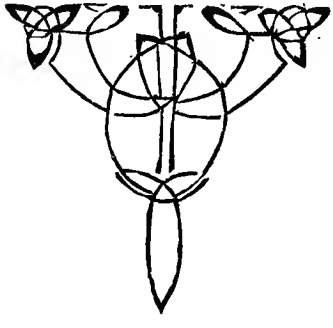
Citronella Grass. *(Andropogon Nardus)*:—Citronella grass is cultivated chiefly in Ceylon, and to a minor extent in the Malya Peninsula, at the present time. It grows remarkably well from sea level up to an elevation of 2,000 feet or more. It is a large coarse grass reaching a height of about four feet and thrives well on even the poorest of laterite soils; at one time it was grown in

Malaya to some extent for the production of the essential oil but at present it is grown chiefly as a means of preventing soil wash and is frequently seen planted in contour rows on hilly land for this purpose.

The plant is readily propagated by root division and is planted at distances of two to three feet apart in the row. A plantation, once established, needs little attention after planting. The grass is ready for cutting when about eight months old and two cuttings a year may be obtained. The yield of marketable oil which is obtained by distillation in steam varies from 22 to 28 lbs. per acre for the first crop and about 15 lbs. for the second or an annual yield of about 40 lbs. It is reported that the yield decreases as the plant ages, consequently replanting every five years is recommended. The yield also varies with changes in season. The oil has a characteristic odour and is used mainly by soap manufacturers.

Lemon Grass. *(Andropogon Citratus)* :—This grass is very similar to citronella in appearance although less luxuriant in growth and thrives under similar conditions of cultivation. The oil obtained in a manner similar to that of citronella is used in the manufacture of perfumes and soaps. The demand for the oil has increased considerably. The grass is cultivated to a considerable extent in Southern India. The yield varies according to soil and climate but with two crops a year the return per acre is considered to be about five thousand bundles (each six inches in diameter) capable of yielding one hundred quarts of oil.

The oil has a characteristic lemon-like odour distinguishable from that of citronella oil.



Spices.

- Vanilla.
- Cloves.
- Nutmegs.
- Pepper.
- Cinnamon.

CHAPTER VII.

Spices.

SPICES are of importance chiefly in connection with the maufacture and consumption of foodstuffs and beverages being employed essentially for flavouring purposes and as condiments.

The East has for centuries been famed for its production of spices and the early trading between the East and Europe was concerned largely with various spices.

In modern industry, spices are also employed as flavouring agents for medicinal purposes.

Formerly Penang was the source of the finest nutmegs and cloves in the world, but the industry during recent years has almost completely died out. The cultivation of pepper was also formerly of considerable importance in several parts of the Peninsula but has now almost disappeared.

Spices may be described as luxuries rather than necessities of life and consequently any extensive cultivation of these products would soon swamp the market and reduce their value, especially at any time such as the present, when

the world's population is not in a position to purchase or consume products other than those which are absolutely essential to life.

There is probably ample scope for the revival of the cultivation of a number of spices in Malaya especially by the native small holder and also the European land owners on small areas.

VANILLA.—(*Vanilla planifolia*).

Vanilla is the product of a large climbing orchid, which is a native of Mexico and Central America. It is one of the few important spice plants indigenous to tropical America. This plant has been introduced into all parts of the tropics, and is cultivated fairly extensively in the Seychelles, Tahiti, Reunion, Comoro, Madagascar, Mauritius, Ceylon, and Java, and the West Indies. The vanilla of commerce is obtained from the cured pods.

Climate:—Vanilla requires a moist tropical climate, with frequent but not excessive rains. It cannot withstand drought or excessive moisture.

The cultivation of the plant has been tried in the Botanic Gardens, Singapore, where, according to Ridley, it grew very well and strong, but as the period during which the fruits ripen coincides with the wet season, it cannot be cultivated in this region with much success, since if heavy rain-storms occur during the ripening period the pods are apt to fall unripe and are spoilt. Since the plant usually flowers in June and July and the fruit ripens about December or January, a district must be selected in which the rains are not so violent at the end of the year.

Cultivation:—The plant thrives best in soils rich in humus ; stiff clays and water-logged soils being most unsuitable. Owing to its climbing habit it requires support, in the form of a hard-wood trellis or a light-foliage shade tree, such as the dadap.

The plant is propagated from cuttings, one to two feet long, which are either planted in nursery beds or in the field. When planted in nursery beds a small stick is placed near the cutting to enable it to start climbing. The beds should be shaded and watered during dry weather. When the cuttings are planted in the field, they are placed near the

base of the permanent supports, which should be at distances of eight or nine feet apart, the cuttings being tied up to the supports until established. Under good conditions, from a cutting of three to four joints a plant of ten to twelve feet in length will have grown by the end of the second year and should commence flowering in the third year. The flowers require artificial pollination and for this reason the plants should be kept as low as possible. A trained coolie can pollinate from 600 to 800 flowers per day. Two hundred bunches each containing 15 to 25 flowers may be found on a single plant, but usually not more than 6 flowers on each bunch should be fertilised and a vine should not be allowed to bear more than 25 to 30 pods. In this country the fruits begin to ripen about 4 to 5 months after being fertilised, and should be gathered immediately they show signs of turning yellow.

Curing the pods:—The drying and curing of the pods after gathering is the most important part of the work of the cultivator and requires the greatest care and attention.

The pods after collection are dipped into almost boiling water for about 20 to 30 seconds and then placed in the sun to dry, after which they are sweated or fermented by rolling up in blankets every evening and placing in a closed box. During the day the pods are spread to dry in the sun. The sweating and drying process is continued for about ten days or until the pods have become quite brown. They are then kept for a month before packing to make certain that they are sufficiently dry, after which they are sorted into classes, according to length, ready for packing

Yields:—An acre of good healthy vines (say 680 plants) is considered to give a return of 150 to 200 lbs. of cured pods.

The cropping of vanilla is very irregular and causes considerable fluctuations in the market prices. The value however depends almost entirely upon the curing and packing. The present price for Mexican pods is from 21s. to 25s. per lb. according to quality, while inferior grades are now fetching from 10s. to 12s. per lb.

Uses:—Vanilla is used chiefly as a flavouring agent for chocolate, confectionery and liqueurs and also in perfumery. The best vanilla only is used for confectionery, the inferior qualities being used in perfumery.

General:—The active principle of vanilla is a substance known as vanillin, which can also be prepared artificially from eugenol, the chief constituent of oil of cloves. The competition of this synthetic product is partly responsible for the lowering of the price of the natural product, which together with possible over-production may affect the future of the vanilla industry.

CLOVES:—(*Eugenia caryophyllata*).

The clove tree is a small conical tree, indigenous to a number of islands in the Moluccas. It is generally about 12 to 20 feet tall, but in some places may attain a height of 40 feet. The cloves of commerce are the dried unopened flower-buds. The tree is cultivated on a large scale in Zanzibar and Pemba, but also in Penang, Amboyna, Sumatra, Ceylon and the West Indies.

Clove Industry in Penang:—The clove plantations in Penang which were formerly of importance are now almost entirely in the hands of Chinese and Malays, who have interplanted rubber, coconuts, and other products amongst the clove trees, with the result that the latter have been gradually forced out of cultivation on many of the plantations. This is responsible for the big decline in the local production.

The following figures show the exports of cloves from Penang during the past two years.

	Quantity. Pikuls.	*value.* $
1919	1,619	102,626
1920	994	115,346

The principal exports from Penang are made to the United Kingdom, Hongkong, Sumatra and the United States of America.

Cultivation:—The clove does not thrive far from the sea and grows best on sloping situations up to an elevation of 1,500 feet. The most suitable soil is a dark loam overlying a subsoil of clay mixed with gravel.

The tree is usually grown from seed, but can be propagated by layering. The seeds are sown 4 to 6 inches apart in nursery beds about 5 feet wide, which should be slightly

raised and shaded. The beds are watered morning and evening if the soil has become dry, but after the plants are above ground watering should be less frequent. When the plants are about 6 inches high they should be gradually hardened by partially removing the shading and left in the beds exposed to the sun for a month or two before planting. The seedlings are usually kept from 9 to 12 months in the nursery beds; they should be planted in the field at distances of 25 to 30 feet apart. The tap root should be kept straight when the young seedling is transplanted. If dry weather is experienced after planting, the young plant must be watered until it begins to throw out fresh leaves. It is sometimes considered advisable to grow the cloves at first under light shade trees, which are cut out when the plants become slightly larger. Pruning is very seldom practised, but it is often advisable to cut out some of the inner branches, if these are too close together. Beyond keeping the ground clean-weeded and clearing the trees of parasites and epithytes, to the attacks of which they are liable, no other treatment is required until the flower buds begin to appear. Manuring with cow-dung or mulching with cut grass or lalang is however very beneficial to the young trees in the early stages of growth.

In Penang the clove tree commences to produce flower-buds in the fourth or fifth year after planting, but it may be considerably later if the soil is inferior. The buds are ready for gathering from November to January. They are green at first, then become yellowish with a pink tint, and finally dull blood-red, when they are fit to gather. When seed is required the buds are allowed to remain on the trees until fully ripe, which takes a further three months. The buds are usually gathered by hand, a hooked stick being used to pull down the higher branches. Cloves should be picked in the best condition, neither too young nor too old. After collecting they should be separated from the stalks and leaves, then spread on dry mats in direct sunlight placing them under shelter at night to prevent wetting by dew. This operation is repeated for about seven days or until dry. Drying with artificial heat is often practised with satisfactory results.

Yields:—In the Straits Settlements a single tree will produce about five lbs. of cloves in a season, which allowing 100 trees per acre, gives a yield of about 500 lbs. of dry cloves per acre. Higher returns up to about ten lbs. per tree can be expected on the best types of land. The best cloves are large and plump, only slightly wrinkled and of a light purplish brown colour with a purplish bloom. If dried too rapidly, they become black.

Clove Oil:—A large quantity of cloves is consumed in the manufacture of clove oil, the inferior qualities being mostly used for this purpose. The whole or ground cloves are distilled in steam to obtain the essential oil which amounts to from 15 to 18 per cent. Clove oil is rich in eugenol. from which synthetic vanillin, similar to the active principle of vanilla, is produced.

The flower stalks, separated from the cloves during drying, are sometimes dried and distilled. They contain about 5 to 6 per cent of oil and usually fetch from 3d to 6d per lb. for distillation purposes.

Uses:—Cloves are used primarily as a spice, the first grades being in special demand for this purpose, whilst the inferior grades are taken for the manufacture of oil of cloves. They are also used to a small extent by natives as a masticatory, being mixed with betel-nut, sireh leaf, etc.

Clove oil is used principally in perfumery as well as in medicine and microscopy; alcoholic extracts of clove oil are used for flavouring confectionery, liqueurs, etc.

Market Price:—The present price of cloves (January, 1922) in Penang is $120/- per picul.

The most recent London market price for cloves is 1s. 7d. to 2s. 3d. per lb. whilst the oil is quoted at from 12s. to 12s. 6d. per lb.

General:—The cloves of Penang have always been most highly valued and have maintained their superiority from the commencement of the cultivation in 1798 to the present day, although the exports from this country are now comparatively small.

Zanzibar is now the biggest clove producing country, exporting over 9,000 tons annually. The market value of the Zanzibar cloves, however, is usually less than that of those exported from Penang.

Nutmegs

(Myristica fragrans):—The nutmeg is a bushy tree about 30 to 40 feet in height, a native of the Moluccas, and introduced into Penang in 1798. The tree is cultivated for

the nutmeg and mace of commerce, the chief countries in which it is grown being Banda, Sumatra, Java, Amboyna, Penang, Celebes, the Moluccas and the West Indies.

The Nutmeg Industry in Penang:—The industry in Penang which is now entirely in the hands of Chinese and Malays, is of very much less importanee than formerly, the plantations both in Penang and Province Wellesley having been gradually replaced by coconuts and during more recent years by rubber,

The exports of locally grown nutmegs and mace from Penang during the last two years were as follows;—

	NUTMEGS.		MACE.	
	Quantity. Pikuls	*Value.* $	*Quantity.* Pikuls	*Value.* $
1919	1,173	109,444	1,078	76,735
1920	1,321	133,596	429	34,449

The principal exports are to the United Kingdom, British India, and the United States of America.

Climate and Soil:—The nutmeg is usually cultivated on the hillsides from about 200 to 1,500 feet, but is rarely found growing at sea-level.

In Penang in which are produced the finest nutmegs in the world, the trees are grown on the steep exposed slopes of granite hills, on which the soil consists of yellow loamy clay characteristic of the laterite formations of the Malay Peninsula Bare clay slopes or sandy soils are considered unsuitable, whilst wet or low-lying ground is fatal to its growth.

Cultivation:—The nutmeg is propagated from seed; only large well-formed seeds should be selected for this purpose. Seeds of irregular shape, or of a pale colour, should be rejected, also those which rattle in the shell on shaking. The seed should be planted as soon a possible after collection, since it quickly loses its vitality.

The seed is planted in well-prepared nursery beds, composed of good soil, at distances of about 12 to 15 inches apart and at a depth of two and half inches. The beds should be shaded and watered every other day or more often if

required. The seeds germinate usually in four to six weeks It is advisable to lighten the shading of the nurseries gradually as the plants grow. The young plants remain in the nurseries till they are from six to nine inches high, or for a period of about six months, after which they are planted in their permanent quarters. Planting in baskets is sometimes practised with good results.

The young seedlings are planted in the field at a distance of twenty five to thirty feet apart. The holes for planting should be at least three feet wide and three deep and filled with good surface soil and leaf-mould.

In planting the tap-root should be kept straight and the soil in the hole well pressed around the root and filled slightly above the level of the surrounding ground to allow for sinking. In hot and exposed situations the plants require a certain amount of shading until they have become established, but the shade can usually be removed after ten to fourteen days. Although permanent shade in the form of light-foliage trees is considered advantageous to the nutmeg, the trees in this country are frequently grown quite in the open.

After the plants are established they require very little attention beyond keeping the ground clear of weeds around the trees. Mulching with cut grass or light manuring with well decomposed cow-dung is very beneficial, particularly on poor soils, since the nutmeg is a heavy feeder.

Pruning is seldom necessary, but all dead branches and parasitic plants should be removed immediately they are found.

Since the nutmeg is unisexual, i. e. male and female flowers are borne on different trees, the number of male trees, if there are too many, should be reduced, leaving one male to every ten or twelve female trees. Unfortunately it is impossible to distinguish between the two until they begin to flower.

Yield :—The trees usually commence to fruit between the fifth and sixth year, but may take even eight or nine years to come into bearing. They attain maximum productivity at fifteen years of age and fruit well for a further ten or twenty years. Trees which commence to fruit early are invariably very short-lived. The fruit is sometimes allowed to fall, but it is preferable to collect it from the tree, using

if necessary a hooked stick to pull down the higher branches A good worker in the full fruiting season will collect from 1000 to 1500 fruits per day.

The yield of nutmegs from individual trees varies considerably, but good trees should average 1500 to 2000 fruits a year. A yield of 750 lbs. of nutmegs and 120 lbs. of mace per acre is however considered satisfactory under ordinary conditions.

The tree fruits more or less throughout the year, but the heaviest crop is obtained usually in July and August. The whole fruit consists of three parts (1) the husk, (2) the mace and (3) the seed or nutmeg of commerce.

Preparation of Nutmegs and Mace:—A few days after collecting, the fruits burst open and the mace is detached from the seed by opening it from the top and turning it back. The fresh mace is of a brilliant red colour, rather tough and leathery, and possessing a peculiar turpentine flavour. After removal the mace is flattened out either by hand or between boards. It is then placed in the sun for a few hours each day until dry, which takes usually from ten to fourteen days.

The husk and mace having been removed, the seed which is still in the shell, is dried in the sun in the same way as the mace. When the seeds are dry they rattle in the shell on shaking and are stored in the shells. As soon as sufficient stocks have been obtained, the shell or seed coat is cracked, which is done either by striking it on one end with a wooden truncheon or more economically by machinery. After the seed is removed from the shell it is very liable to the attacks of insects, especially if stored for any length of time.

Nutmegs are valued according to size and after cracking they are sorted out and graded by weight. The three common grades are those averaging 65, 85 and 110 nuts per lb. respectively. Defective or broken nuts are converted to powdered spice by grinding and used for seasoning or preparation of nutmeg butter and in the oil of nutmegs.

The graded nutmegs are packed in cases or casks ready for export.

Market Price:—The local price for nutmegs at the present time (January, 1922) is $41 and $29 per pikul for 80's and 110's respectively.

The latest London quotations for nutmegs are;—65's @ 1s. 5½d. per lb., 80's @ 1s. 1½d. and 110's @ 9¾d, whilst oil of nutmegs is quoted as 5s. 6d. to 5s. 9d per lb.

Uses:—The nutmeg contains about 25 per cent of a fixed fat which constitutes the nutmeg butter of commerce, prepared by crushing the seeds, heating the meal and expressing the fat.

The nutmeg also contains an essential oil which is obtained by steam distillation of the pulverised nutmegs, the yield of oil being from eight to ten per cent. Mace also yields an essential oil closely related to that of the nutmeg.

Both nutmegs and mace are used essentially as spice and flavouring agents; nutmeg butter is used medicinally as a basis for ointments, whilst oil of nutmegs or mace is employed in perfumery and for flavouring liqueurs.

PEPPER.—*(Piper nigrum).*

The true pepper is a perennial creeping vine, indigenous to Ceylon and Southern India. Both the black and white peppers of commerce are obtained from the dried fruit of the same plant.

The plant is cultivated on a commercial scale in Java, Sumatra, Malabar, Ceylon and the West Indies. It was formerly cultivated on a large scale in Penang, but the industry has now practically died out.

Cultivation:—The pepper vine requires a moist heat with shade and thrives better on flat land than on the slopes of hills. The most suitable soil for pepper is one rich in humus, though with the aid of manures it has been grown successfully on the stiff yellow clay soils to be found in Malaya.

The vine is propagated from cuttings, selected from the tops of the best yielding vines, care being taken not to obtain cuttings from male vines only. The cuttings, which should be about one foot long, are planted in well-prepared nursery beds and buried six inches in the ground. The beds are shaded and carefully watered when necessary. After about a year the cuttings should have become established and can then be planted in their permanent quarters.

The plant requires supports either in the form of hardwood timber or light-foliaged trees. *Erythrina* trees when grown from cuttings about 3 feet long and 2 inches in diameter, are very suitable as supports, the best kinds being *Erythrina lithosperma and E. stricta; Morinda tinctoria* is sometimes used for this purpose. These are planted 7 feet apart and lopped when required.

When the vine cuttings are ready for transplanting they are lifted from the nursery beds and planted a few inches away from the supports, facing east. In this country the Chinese do not utilise living trees to support the vines, but grow them exclusively on stout hardwood posts, about twelve to fourteen feet long and six to seven inches in diameter, which will not be destroyed by white ants or decay before the life of the pepper plant is finished.

The posts give practically no shade at first and the ground between them is usually covered with cut lalang, to act as a mulch.

As the vine ascends it is tied to the post with soft bast or twine and on reaching the top is pulled down and wound round the base of the support. The vines are sometimes manured with fish manure at the rate of about ½ lb. per plant.

Periodical pruning is necessary to prevent the plant from growing bushy at the top: and by the time it has, reached the top of the support it will have been pruned at least three times.

Yields:—The vines will commence fruiting as early as a year after planting but no fruits should be allowed to develop until the plant is fully grown, which will be about the third or fourth year after planting, when it will cover the stake completely. There are generally two crops, one in August or September and the other in March or April, but collection often continues throughout the year. The vines are considered to be in full bearing at the sixth or seventh year and with proper treatment, will continue to yield well until 12 or 15 years of age.

After the sixth or seventh year, an annual yield of 3 to 3½ lbs. of dry pepper per vine is obtained, which with 889 vines to the acre, is equivalent to approximately 2,500 to 3,000 lbs. of dry pepper per acre per annum.

The local prices (January, 1922) for pepper are :—Black $14/- and White (Sarawak) $25/- per pikul, respectively.

Curing :—Black pepper consists of the ground whole dried berries. When this form of pepper is required the spikes are gathered when only a few of the fruits are ripe and red, and placed on mats to dry in the sun. The quality of the pepper can be considerably improved by plunging the berries into boiling water for a few minutes immediately before they are spread out to dry. This "kills" the green fruit, which would otherwise take some time to wither, and accelerates the drying process. When the pepper is dry it turns quite black and is than rubbed by hand to separate the stalks, which are afterwards removed by winnowing.

When large quantities of berries have to be dried quickly, drying rooms with artficial heat are generally used.

White pepper consists of the ripened berries deprived of their black covering before grinding. In order to obtain a good quality white pepper the gathering is delayed until nearly all the berries on the spikes are of a red colour, but as the fruits on the same spike ripen so irregularly this is not always possible.

After gathering, the fruits are detached from the branches by pressing them underfoot. The berries are then put in large bags and placed in running water, where they are allowed to soak for seven to ten days. When the skins are sufficiently loose and soft the berries are put into tubs, where they are stamped underfoot in a little water and washed until all the skins, pulp and stalks are removed. The pepper corns are then taken out of the tub and placed on mats to dry in the sun.

Uses :—The chief use of pepper is as a spice or condiment. It is also used for medicinal purposes.

Cinnamon.—*(Cinnamomum zeylanicum.)*

The true cinnamon is a medium sized tree, 20 to 40 feet high, native to Ceylon and Southern India. In cultivation the tree is grown as a coppiced bush the bark of which produces the cinnamon of commerce.

Climate and Soil :—In Ceylon the tree thrives well up to an elevation of 2,000 feet. The type of soil in which it

flourishes best is a sandy loam mixed with a good proportion of decayed vegetable matter.

Cultivation :—The tree is usually grown from seed but can be propagated from cuttings or layers.

The seeds are either planted at stake or raised in nursery beds in clumps of about twenty five seeds. When planted in nursery beds the clumps of seed should be placed about six inches apart each way and then covered to a depth of about one inch with fine soil. The beds are shaded and the plants carefully watered during dry weather. When the seedlings are about six to eight inches high the shade may be gradually removed. When nine to twelve months old the seedlings are ready for transplanting, and are removed from the nursery beds and planted in clumps at distances of from six to eight feet apart in the field.

After the plants are once established little further cultivation is necessary beyond keeping the land free from weeds, particularly climbing plants which may interfere with the growth and at the same time damage the bark by twining round the young stems of the cinnamon. As the plants develop they will produce sufficient shade to check the growth of weeds. Beyond mulching with weeds, fallen leaves, etc., manuring is seldom practised.

Harvesting:—Under favourable conditions the shoots will be ready for harvesting in the third or fourth year, when a yield of 50 to 60 lbs. of dry bark may be expected. After the first cutting, the number of shoots increases each year until the eighth or tenth year when a yield of 100 to 150 lbs. of bark will be obtained. Since one or more shoots appear from each clump after every cutting, and there are two cuttings a year, the plantation finally becomes a thicket containing young wood of different ages.

Cutting takes place twice a year during the rainy seasons when the sap begins to circulate between the wood and the bark. Shoots selected for cutting are usually of two years' growth.

The shoots which are fit for peeling are cut and the tops and branches removed, leaving sticks from three to four feet long. The Sticks are collected, tied in bundles and carried to the peeling sheds.

Preparation:—The operation of peeling off the bark is carried out by making two longitudinal slits, one on each side of the shoot, with a special knife, which has a projecting point on one side for ripping off the bark.

When cutting has taken place in wet weather the bark is removed easily, but it is usually necessary to rub the sticks firmly with a piece of hardwood in order to disengage the bark. The pieces of bark thus separated are collected in bundles, pressed and bound together. They are then covered with a mat and left overnight to undergo slight fermentation which allows of the cuticle being easily removed by scraping with a curved knife. The pieces of bark are then sorted out into different qualities and having selected a large slip suitable for the outer cover, the small pieces are packed together inside so as to from a pipe. These are allowed to dry in the shade until they are sufficiently firm for handling, when the ends are pressed in and trimmed off neatly. They are then dried again in the sun, when they contract and have the appearance of quills. The sizes of the pipes vary according to quality, finer sorts varying from fifteen to twenty to the pound, inferior sorts from ten to fifteen. After grading, they are packed in bales of about ninty lbs. each for export.

The pieces which are trimmed off are known as "cinnamon chips" and these, together with the bark removed from the larger shoots, which cannot be made into quills, are used for the preparation of oil of cinnamon. The inferior pieces of bark, broken quills, chips, etc. are reduced to a coarse powder, macerated in a saturated solution of common salt for two days, and then submitted to distillation. The yield of oil, which varies considerably according to the quality of the bark, is usually from half to one per cent. Essential oils can also be obtained from the leaves and the roots of the cinnamon, but they are infeiror to that prepared from the bark.

The latest London quotation (January, 1922) for the essential oil is (B. P. quality) 3s. per oz. but up to 7s. per oz. is quoted for the finest grades

Uses:—The dried bark is used mainly as a spice. It is also used medicinally as a cordial and stimulant and in the manufacture of incense.

Oil of cinnamon is used extensively in perfumery and medicines.

Drugs.

Ipecacuanha.

Cocaine.

Cinchona.

CHAPTER VIII.

Commercial Vegetable Drugs.

NEARLY all the older drugs of commerce are of vegetable or plant orgin, until comparatively recent years most drugs were used in the form of extracts or tinctures of the plants or parts of plants containing the medical principle. The word "drug" is still generally employed in its original sense, as meaning the dried part of the plant used for medicinal purposes, although its use has also been extended to the pure products now prepared from the raw dried material.

Modern researches on poisonous and medicinal plants have shewn that the toxic or medicinal constituents are frequently present in varying proportions in the plant, so that the extracts and tinctures unless standarised after investigation are variable in character. In many cases in which an extract of the plant was formerly prepared and employed by the ordinary pharmacist or druggist, the medicinal principle is now isolated in a pure state on a large scale by larger pharmaceutical or fine-chemical manufacturers so that definite doses can be applied.

Cinchona bark is still purchased chiefly on its appearance for pharmaceutical use in the manufacture of extracts and tinctures, whereas the manufacturer of quinine and the other alkaloids from cinchona bark, purchases his raw material entirely on an assay of the alkaloid content of the bark. Ipecacuanha root which was formerly employed in the form of an extract or tincture is now largely used in the manufacture of the pure alkaloid emetic. Similarly the leaves of the Coca plant are used chiefly for the preparation of cocaine, while large quantities of opium, the dried extract from the poppy plant, are used for the preparation of pure morphine and other alkaloids.

The toxic or medicinal constituents of other crude plant drugs have not yet been isolated in a pure state and extracts of such drugs are still employed.

The vegetable drugs may be obtained from the flowers, fruit, seed, leaves, stems, roots, rhizomes, tubers or bark of plants and in some cases are contained in all parts of the plant.

Thus quinine and other allied alkaloids are obtained from the root and stem bark of the cinchona tree, strychnine is obtained chiefly from the seed of the nux vomica, cocaine from the leaves of the coca plant, santonine from the dried unexpanded flower heads of *Artemisia maritima*; sarsaparilla from the dried root of *Smilax ornata*, castor oil from the seeds of *Ricinus communis*, etc.

The following articles on drug plants which might be cultivated profitably in Malaya contain details of methods of cultivation, harvesting of the crop and market prices.

It must be pointed out however that the market for drugs is limited and would soon be swamped, with the resulting drop in price of the drug, if these plants were cultivated on a large scale by many estates, They offer opportunities however to small holders or for cultivation on a small scale on a number of estates.

At the present time, it is stated that there is a probability of over-production of quinine which is one of the most important of drug plants under cultivation.

Ipecacuanha has been cultivated profitably for some years by one estate in the Federated Malay States but if the cultivation were taken up on a large scale there would soon be a glut on the market.

Apart from the three drugs, the cultivation of which is discussed in the articles which follow, there may be others, the cultivation of which might prove profitable. These are now being cultivated by the Department on an experimental scale and information on their possibilities will be published later.

Ipecacuanha. *(Psychotria ipecacuanha.)*

The ipecacuanha plant is a small perennial shrub, indigeneous to the dense humid forests of Brazil.

Most of the ipecacuanha of commerce is derived from Matto Grosso in Brazil. The United Kingdom imports about 50,000 lbs. annually, and the United States of America a similar quantity.

Cultivation:—The plant is readily propagated from root cuttings, which should be taken preferably from mature plants. The cuttings are prepared by slicing the fresh roots with a sharp knife into small pieces about a quarter of an inch in length. These are placed in a horizontal position in boxes of specially prepared soil consisting of a mixture of two thirds sand and one-third humus. After planting the cuttings, a thin layer of sand is put on the surface and the boxes carefully watered. Under such conditions the cuttings will strike in about one month and at the end of two months they should be pricked off about four inches apart into other boxes filled with equal parts of sand and jungle mould. Shade and moisture are essential, and under careful management the rooted cuttings should be ready to plant out into permanent beds at the end of six months,

When the young plants are sufficiently large they should be planted out at distances of from twelve to eighteen inches apart in well-prepared beds about five feet wide, the soil having been previously trenched to a depth of at least two feet to allow the roots to penetrate. Raised beds are preferable, and good drainage essential. After planting in the permanent beds the surface soil should be kept loose by light forking with small hand forks to a depth of two or three inches, at intervals of about a month. The plants require shade throughout their period of growth and regular watering during dry weather. Excessive moisture, however, is detrimental and care should be taken to give only the requisite amount.

Yield.:—The roots may be harvested at about two to two and a half years from the date ot planting out into the permanent beds. A healthy plant will yield from six to eight good roots, which after drying weigh from one to two ozs. On a large scale the average yield is usually much less, the estimated weight of dried root being about 600 lbs. per acre per annum.

The roots are prepared for market by drying and this must be done as quickly as possible. The common method employed is ordinary sun-drying, the roots being placed under cover at night to avoid damp caused by dew. Drying can be accelerated considerably, without affecting the quality of the roots, by using artificial heat

Ipecacuanha is prepared from the dried roots of the plant which only yield about one per cent of the drug, consisting of the three alkaloids, emetine, cephaeline and psychotrine, as well as ipecacuanhic acid.

The present market price of dried root is six shillings per lb., which is approaching the pre-war value.

Uses:—An extract of the roots and the pure alkaloids are used in medicine. The principal alkaloidal constituent, Emetine, is largely used as a specific for dysentery.

General:—Although ipecacuanha has been grown successfully in this country, particularly in Selangor and Johore, it should be pointed out that there is only a limited demand for this drug, and any attempt to cultivate the plant on a large scale would have the effect of reducing its market value considerably. Further, its cultivation requires much labour and supervision and therefore the plant is costly to grow on anything approaching a field scale.

Coca or Cocaine Plant. *(Erythroxylon Coca)*

The coca or cocaine plant is a small bushy shrub, six to eight feet high, indigenous to Peru and Bolivia, where it grows wild at elevations of 4,000 to 6,000 feet, It is also extensively cultivated in its native habitat from which the dried leaves which constitute the raw product are exported to the extent of 800 to 900 tons a year. The drug cocaine is extracted from the dried leaves.

Cultivation:—The plant is easy to cultivate and grows very rapidly from seed, which it produces in great abundance. The seeds should be sown fresh in carefully prepared nursery beds, and the ground covered with cut grass or other litter. If the red pulp is washed off the seeds previous to sowing they should germinate within ten to fourteen days. The nursery beds should be shaded in the early stages, but the shade should be removed when the plants are established. After germinating, the seedlings should be thinned out as desired. When the seedlings are ready for transplanting, which usualy takes about seven to nine months, they should be transferred to the field and planted at distances of from four to six feet apart.

Crop:—The first picking of leaves can be made at about one and a half to two years from the date of planting, after which several pluckings of leaves can be made each year for many years before the plants require to be removed. Only the mature leaves should be removed as they have the highest alkaloidal content.

The bushes can be periodically pruned without injury. The leaves are preferably dried in the shade or by artificial heat in order to retain, as far as possible, their light green colour. In a good sample the leaves are bright green, unbroken, and have a pleasant aroma, These characters can only be obtained by collecting the leaves carefully and drying them as rapidly as possible without exposure to excessive heat. Sun-dried leaves have a brownish green colour and are considered to contain less cocaine. The dried leaves should be preferably packed for export in zinc-lined air-tight cases to keep out moisture and prevent fermentation, which considerably reduces their value.

Yields:—It is estimated that, under good conditions, a yield of from 1,500 to 2,000 lbs. of dried leaf per acre per annum can be obtained.

The present market price for first quality dried leaves is about 2s. per lb.

Uses:—The drug, Cocaine, is prepared from the dried leaves, which usually contain about one per cent of the alkaloid. It is used principally as a local anaesthetic, but its use, like that of morphine and other drugs has been considerably abused during recent years.

General:—Cocaine, like most other drugs, is only in limited demand, and if a large quantity of dried leaves was

suddenly placed on the market there would be a rapid fall in prices. Its cultivation on a large scale would therefore be attended with a certain amount of risk on the part of the cultivator. The plant was formerly cultivated in Java on a commercial scale, but it is understood that at the present time only a small quantity of dried leaves is exported from that country.

Cinchona.

Quinine is obtained from the bark of several species of Cinchona, which are medium sized trees, 25 to 40 feet high, indigenous to Bolivia and Peru. Cinchona was originally introduced into India and the original stock in Java was derived from India. The two species most commonly cultivated are *Cinchona Ledgeriana* (Ledger's bark) and *Cinchona succirubra* (Red bark). The former is much richer in quinine than the latter and is the variety chiefly grown in Java, which is now the biggest quinine producing country in the world. In Ceylon, where the cultivation of Cinchona has of recent years greatly diminished, the variety mostly grown was *Cinchona succirubra.*

Cinchona is still cultivated in India which also possesses two factories for the manufacture of quinine.

Soil and climate :—The tree thrives best in a rich loam with a fairly porous subsoil, but in Java, where it is cultivated so successfully, the soil if of volcanic origin. *Cinchona Ledgeriana* gives the best results at an elevation of 4,000 to 6,000 feet while *Cinchona succirubra* is more suited to the lower elevations and is usually grown at a height of 2,000 to 4,000 feet.

Cultivation :—Where virgin land is available it is generally planted with Ledgerina seedlings, but land on which this variety has been previously cultivated is usually replanted with grafted stocks of succirubra-Ledgeriana.

The plant is propagated from seed, which is sown in very carefully prepared beds in seed-sheds, the beds being composed of fresh jungle mould to a depth of about two feet. These beds are shaded on all sides in order to protect the young seedlings from the sun, rain and wind. When the beds are ready for planting, the seed (Ledgeriana) is sown very thickly, lightly covered with soil and watered when necessary. Although it is most important to keep the beds moist, excessive watering is detrimental and should be

avoided. When the seedlings are about two inches high, which may take from five to six months, they are transplanted into other nursery beds at distances of about five or six inches apart. When the young plants have reached a height of twelve to eighteen inches, they are ready for planting in the field.

In the case of estates on which no virgin land is available for further planting, the system of grafting is adopted for maintaining the quinine content of the bark. In this method the *Cinchona succirubra* is sown in the manner described above, except that the plants are allowed to remain in the nursery beds until about too years old. At this age when the plants are about three feet high, cuttings taken from Ledgeriana trees, of known high quinine content, are grafted on to the succirubra plants at the base of the stem and covered over with grafting wax. The grafted plants will usually be ready for planting in the field after a further eight months, but they may be left longer in the nursery beds if necessary.

It is estimated that two coolies will graft from 400 to 600 plants a day.

When the grafted stocks are ready they are planted in the field very thickly, up to 4,000 plants per acre.

From the third or fourth year after planting, cropping by selective thinning and pruning is carried out annually, and is continued for a period of 15 to 25 years, according to the nature of the soil. The percentage of quinine in the bark is at its maximum about the eighth year after planting.

Yields:—When ready for cropping the trees are dug out with the main root intact since the root bark, as well as the stem bark is rich in alkaloids. The bark is readily removed from the roots and stems by striking them with heavy wooden mallets, by which process it is removed in pieces of varying sizes. These pieces of bark are then placed in the sun to dry for a few days, followed by artificial drying in a drying room at a temperature of about 80°C., the resulting product being used for the manufacture of quinine.

Much more care, however, is necessay in the harvesting and preparation of bark for pharmaceutical purposes, owing to the remarkable fact that pharmaceutical bark is still brought and sold on the market entirely by appearance and

not according to its quinine content. For this purpose it is removed in large pieces and carefully handled so as not to disturb the moss on the outside.

At the present time the whole of the pharmaceutical bark is obtained from the succirubra species, but there is only a very limited demand for this product.

The manufacturers of quinine and the other alkaloids and their salts purchase the bark on an assay of its content of quinine.

It is estimated that an average yield of 2 lbs. of bark per tree per annum or about 600 lbs. of dry bark per acre can be obtained on good Cinchona plantations in Java. Although, in some cases, the quinine content has been increased to as much as fifteen per cent of alkaloid, by grafting with high yielding strains, the average quantity of alkaloids in the dried bark is usually about six to seven per cent.

Uses:—Quinine and the allied alkaloids, cinchonine, cinchonidine quinidine, together with a number of other amorphous alkaloids constitute the active principles of the bark. The sole use of quinine is for medicinal purposes, principally in the treatment of malarial fever.

Extracts of the bark containing the other alkaloids in addition to quinine are also employed medicinally.

Fibres.

Sisal Hemp.

Mauritius Hemp.

Bowstring Hemp.

Manila Hemp.

Roselle Fibre.

Kapok (Kabu Kabu).

CHAPTER IX.

Fibres.

THE fibres of commerce are classified usually as hard or soft according to their texture and uses, their application depending partly on their texture and also on other qualities, principally capacity for spinning.

Only about twelve of the large number of known fibres in the world have been utilised commercially.

Flax has been in use for centuries while hemp (*Cannabis sativa*) was utilised later, but long before some of the tropical fibres now in use.

The principal hard fibres of commerce, which are derived entirely from plants, are Manila, Sisal, Mauritius, Bowstring and New Zealand hemp. These fibres are used almost entirely in the manufacture of cordage, i.e. ropes, twine, etc. The increasing use of mechanical harvesters for the harvesting of cereal crops has absorbed a large quantity of the hard fibres in the form of binder twine.

At the present time the world's consumption of hard fibres is over 350,000 tons.

The following figures for the year 1915 are of interest and show the principal countries of origin of the chief hard fibres :—

		Tons.
Philippines	Manila Hemp or Abaca (*Musa textilis*) ...	140,000
Java	Manila Hemp ...	600
Mexico	Henequen (*Agave fourcroydes*)	135,000
Cuba	„ ...	3,000
Java	Sisal (*Agave rigida var Cantala*) ...	6,500
Bahamas	„ („ „ *Sisalana*) ...	4,300
B. E. Africa	„ („ „ „)	3,750
Hawaii	„ („ „ „)	1,000
Portuguese E. Africa	„ (*A. rigida var sisilana*)...	600
German E. Africa	„ („ „ „)	nil
New Zealand	New Zealand Hemp (*Phormium tenox*) ...	23,225
	Total. ...	317,975

In 1913 German East Africa exported 20,000 tons of Sisal hemp

In Mauritius and a few other countries, Mauritius hemp (*Furcraea gigantea*) is cultivated on a small scale, but is said to be less suitable than Sisal, also the percentage of fibre in the leaves is lower than in the case of Sisal.

Bowstring hemp (*Sansevieria spp*) is at present a jungle product, but appears to offer possibilities as a subsidiary crop on old rubber estates.

The soft fibres, which are used in the manufacture of textiles of different quality, include flax, jute, hemp, cotton, kapok, silk and wool of which the first five are derived from plants.

As is well-known the increase in the use of jute was enormous during the war largely owing to the demand for sand bags. In this handbook only kapok, among the soft fibres, is discussed, since investigations on cotton cultivation are at present in an early experimental stage in Malaya and it is doubtful whether its cultivation here will be successful, chiefly owing to climatic conditions.

In addition, Roselle fibre, which closely resembles jute, is discussed, since a serious attempt is being made to establish the cultivation of this fibre plant in Malaya. At present it is not one of the commercial fibres of the world and its market value and possibilities have not yet been establised.

During the war period the price of fibres rose enormously but at the present time there is considerable fluctuation and prices have decreased.

The following prices are quoted on the London market during December, 1921 :—

Jute (Diamonds)	£50 per ton,
Jute (Other qualities)	£20-26 per ton.
Jute (Bimlipatam)	£21-22 „ „
Sisal Hemp (Mexican)	£27-33
Sisal Hemp (Java)	£33-40
Sisal Hemp (African)	£35-39
Mauritius Hemp	£30-50
New Zealand Hemp	£33-35
Manila Hemp	£31-50
Maguey (Sisal) Manila	£26-29
Ramie fibre	£65
Kapok (Java)	12d-13d per lb.
Kapok (Ceylon)	6d-7d per lb.

The experimental cultivation of Sisal and Mauritius hemp has been carried out for several years by the Department of Agriculture, but no yields have been recorded. Samples of Mauritius hemp have been reported on favourably and a specimen of Bowstring Hemp prepared at the Department of Agriculture has been valued recently at £40 per ton while samples of Roselle fibre have been valued at £20 per ton for uncombed and £30 per ton for combed fibre.

Manila hemp, Sisal hemp and Mauritius hemp can all be grown in Malaya and appear promising, although no definite information is available as to the probable profits.

In the marketing of fibres, considerable care and attention has to be paid to grading and baling. In the case of Manila hemp there are about ten grades on the market and in the Philippines, from which the greater part of Manila hemp is derived, a Government grading staff exists for this purpose. The establishment of such a staff would only be justified if large areas were grown.

Sisal and Mauritius hemp can be prepared by retting, but the fibre is usually extracted in special decorticating machines, since the decorticated fibre is said to be stronger and better. Consequently it is necessary to establish large plantations, in order to run a factory economically. Since the proportion of fibre in the leaves is only three to four per cent it is not economical to transport the leaves for a long distance to central factories. Manila hemp and Roselle fibre are prepared by hand and small areas can be cultivated economically.

Fibre machinery can be purchased from the following firms:—

Messrs. Marshall & Co. Gainsborough, England.

Messrs. Robey & Co. Ltd., Lincoln, England.

David Bridge & Co., Castleton Iron works, Castleton, Lancashire, England.

Ernest Lehmann, 8, Chatham Buildings, Chatham St. Manchester, England.

Prieto Machine Co. Inc. 45, Broadway, New York, U. S. A.

A complete plant for fibre extraction consists of a decorticating machine, crushing rolls for thick and hard leaves, a brushing machine and a baling press, with necessary prime mover in the form of a steam, oil or gas engine or motor, shafting, belting, etc. and a building of a suitable size.

A decorticator can produce about 400 to 500 tons of fibre per year, representing leaves from 400 to 500 acres, and one machine is sufficient for 1,500 acres in the case of Sisal.

Fibres for export must be baled under pressure to save excessive freight charges. A suitable weight for bales of fibre is about 2 cwt. and the fibre should be pressed so that a ton occupies 70 cub. ft.

Details of cost of factories for the extraction and baling of fibre can be obtained from the Department of Agriculture.

Sisal Hemp. (*Agave rigida var sisalana*),

There is a large number of varieties of Agave (Sisal) but only three are in general use viz. *Agave rigida var elongata* (Mexican Sisal). *Agave rigida var sisalana* and *Agave cantala*. The last named is said to stand a higher rainfall, hence its success in Java.

The sisal plant is propagated from the small plants known as "bulbils" that arise in the axils of the flower stalks or from suckers from the rhizome.

Nurseries:—The bulbils are planted on nurseries which should be tilled to a depth of about one foot, the beds being about four feet wide, with one foot paths between. The bulbils or suckers are spaced nine inches apart in the nursery beds. Shading is unnecessary and watering seldom required; weeding, however, is important. The plants are generally kept in the nurseries for about one year. Suckers may also be detached from the parent and planted direct in their permanent quarters. Bulbils can be supplied by the Department of Agriculture from time to time at a cost of one cent each; approximately 900 are required per acre.

Planting and Cultivation:—The most suitable soil is a fairly dry, permeable, sandy loam, containing a small amount of lime. Good drainage is essential as the roots of the plants are liable to be damaged by standing water. On poor soils, the plants make inferior growth, but are said to contain a larger proportion of fibre than plants grown on too rich land. Hilly land is well suited for sisal cultivation as it allows of easy drainage. It is not necessary to break up the land, but all undergrowth must be removed. Holes one foot deep, are made in rows eight feet apart and six feet apart in the rows, which allows about 900 plants to the acre. Planting should be undertaken during the rainy season, all fibrous roots and lower leaves having been first removed to facilitate new growth.

Systematic weeding is necessary throughout the period the crop occupies the land. Light tillage to a depth of three or four inches is recommended when the clearing is about one year old, subsequent tillage is unnecessary.

Harvesting;—The period before harvesting varies but, in general, cutting commences within three years of planting out or about four years from the planting of the bulbils in the nursery. The leaves, when ready for cutting, are removed

close to the trunk, care being taken not to injure the younger leaves of the plant. The number of leaves which can be cut per annum varies considerably; in Mexico twentyfive is the average whilst in East Africa double that number is obtained. The estimated yield under good conditions is from 1000 to 1,200 lbs. of dry fibre per acre; one ton of raw leaf will produce between 60 and 80 lbs. of dry fibre.

The duration of life of the plant is determined by the production of the pole or inflorescence, the average length of life in Malaya being about eight years. This is a much shorter period than is the case in Mexico and is chiefly due to the local climatic conditions. It is stated, however, that this is no disadvantage as the same total crop is produced in a relatively shorter time.

In view of the fact that the raw leaf only produces from three to four per cent of dry fibre the cost of transport to a central factory would be prohibitive; it is therefore necessary to install machinery in the locality of the plantation. At least 1,000 acres should be planted to warrant the erection of a factory installation of the necessary machinery for the production of first quality fibre.

Preparation of fibre:—The leaves should be treated in special decorticating machines within 24 hours of cutting. A woman is said to be able to cut 600 leaves per day and a man 800.

A "Corona" decorticator is said to treat 100,000 to 150,000 leaves per day, producing two to two and a half tons of fibre per 8-10 hours day. The decorticated fibre is hung on poles to dry in the sun for two days, and is brushed in special brushing machines to remove any extraneous matter, pulp etc. A constant supply of good water is essential for the factory. Sisal hemp fibre can be prepared also by retting by hand labour but the fibre is said to be weaker and of inferior colour to fibre prepared with decorticating machinery.

A labour force of one coolie per two acres is said to be required and a European Manager can supervise a large area comprising about 5,000 acres.

Well prepared Sisal fetches a price second to Manila hemp on the market, being at present about £35 to £40 per ton, which is said to be about double the working expenses.

Agavè cantula:—The Henequin of Yucatan, *Agave rigida var elongata ;* the Sisal of Hawaii, *Agave rigida var: sisalana;* and the Maquey of the Philippine Islands, recently identified at the Royal Botanic Gardens, Kew, as *Agave Cantula*, are very similar plants. All have the short, thick stem, the aloe-like cluster of large, fleshly leaves, and the tall flower stalk or "pole", which bears a large number of small "bulbils", or pole plants. The Hawiian plant differs from that of Yucatan in having a shorter trunk, leaves smooth-edged, or bearing a few unequal teeth and the fibre less in quantity, but superior in quality. *Agave Cantula* is said to be the variety cultivated in Java and prepared by retting.

MAURITIUS HEMP :—*(Furcraea gigantea)*

Mauritius Hemp is very similar in habit of growth to Sisal Hemp an d the cultivation is also very similar except that the former is planted a little wider apart, say eight feet by eight feet. The method of preparation of this fibre is similar to that in the case of Sisal.

The quality of Mauritius hemp is not so good as that of Sisal and therefore has a lower market value.

It can be propagated only by "bulbils" since no suckers are produced.

Recent experiments carried out at the Department of Agriculture to determine the precentage of fibre produced from freshly cut green leaves of various varieties of hemps have yielded the following results:—

	Dressed fibre. per cent.	*Total fibre.* per cent.
Furcraea gigantea (old plants)	1.82	2.24
„ „ (young plants)	2.74	3.28
Agave rigida var. sisalana	3.79	4.49

The fibre was extracted in each case after the leaves had been retted for eighteen days.

These results show that Sisal produces a larger percentage of fibre than Mauritius, also that the young Mauritius produces a higher precentage than the old, indicating that it is unprofitable to allow Mauritius to become too old before cutting.

The higher percentage of fibre produced by the Sisal as compared with the Mauritius, together with the fact that the former commands a higher price in the market, points to the advisability of growing Sisal.

It must, however, be noted that Mauritius produces a heavier crop of leaves per acre, and the question which remains to be decided is which class of fibre is the more profitable under Malayan conditions. This will depend on which makes the better growth in any locality, due allowance being made for the heavier charges for handling the Mauritius,

The herbaceous plant Bowstring hemp has succulent leaves, blotched with gray and attaining a height of from two to three and a half feet or more. This plant yields fine, white, tough and elastic fibre. It is commonly found as an ornamental plant in gardens, and is well distributed throughout Malaya. It is indigenous to India and Ceylon, and is to be found growing in a large variety of soils, but thrives best in those which are fairly friable, and under partial shade throughout its period of growth ; it appears to do well under the shade of old rubber. This fact is of special interest, as it might prove a useful crop in old rubber clearings ; thinned out areas would probably give the necessary amount of shade.

The plant is propagated by seed, division, or leaf cuttings, the latter being more convenient. The distance of planting is about two feet apart, each way. The yield is reported to be one and a half tons per acre, as a sole crop.

There are many species of Sansevieria, the leaves of which yield a fibre suitable for cordage manufacture, found in most tropical countries. There are two very common types to be found locally. These plants have large, thick underground stems or rhizomes which throw out numerous branches. The leaves arise from the base of the plant and vary in length. They are of a succulent nature, generally flat and wide, but some are thick and narrow.

A sample of fibre prepared from locally grown plants was recently forwarded to London and reported on as follows:—

A hard clean fibre; strength, good; height, fair; colour, dull white; preparation, good; texture, fine; value £40 per ton (7—10—21).

It was pointed out that small quantities would be more difficult to sell than larger quantities, as manufacturers would not care to touch it, unless they could get supplies on a fairly large scale, say 1,000 tons.

Fibre is extracted from the leaves by methods similar to those employed in the preparation of Sisal Hemp. The material is usually shipped in bales of four to five cwt.

Experiments on the cultivation of this fibre under varying conditions of shade are being carried out at the Department of Agriculture in order to ascertain the value of this fibre plant as a subsidiary crop with rubber.

MANILA HEMP.—*(Musa textilis.)*

Manila hemp is derived from the sheathing leafstalks of *Musa textilis*. The plant requires a loose moist soil, rich in humus and well drained, and appears generally well suited to Malayan conditions; it will not thrive on swampy land, or land liable to damage by surface wash. Manila hemp is propagated by means either of root cuttings, or more commonly from the suckers which arise at the base of the parent plant; but sometimes it is grown from seed, the latter taking longer to reach maturity. Seeds must be collected from fruits which have not become over-ripe.

Planting:—Plantations are usually established by means of suckers planted out when about three feet high and spaced 8 to 9 feet apart. Holes are made 2 feet each way and left exposed to the influence of the atmosphere for a time. Previous to planting, the holes are filled in with the rich surrounding soil.

Cultivation:—Subsequent tillage, beyond weeding, is unnecessary. The estate must always be kept free from lalang. This fibre responds well to the application of potash and lime, particularly the former; consequently recently cleared jungle land is usually suitable for its cultivation.

Harvesting:—The stems are ready to be treated for fibre just before the plants begin to flower, when they are cut about a foot from the ground and the leaves removed.

Each stem is then stripped into its component layers. The outer leaf sheaths contain a coarser and stronger fibre than the inner, while the fibre from near the middle is of a fine silky texture. Inferior grades are suitable for paper manufacture.

Preparation of Fibre:—In preparing the fibre, each strip is taken by hand, and drawn between a blunt knife and a smooth board attached to a light frame. The fibre is then dried in the sun and packed in bales for shipment.

The first crop is obtained two years after planting and a full crop in the fourth year, plantations continuing to yield for about fifteen years. The usual return is said to be from 600 to 850 lbs. of dry fibre per acre, from the fourth year, but with good cultivation, the yield could be increased; a half ton per acre is usually regarded as very satisfactory.

Manila hemp has been grown at the Kuala Lumpur Gardens for some time and the results thus far obtained, on even comparatively poor land, are extremely promising, The original suckers were procured from the Philippines and represent one of the commercial varieties grown there. Recently, seed of special varieties, suited to various types of soil, have been imported, and experiments are to be conducted with these varieties.

This fibre might be grown by the small holder, since Manila hemp is prepared by hand labour and there would be little difficulty in securing a market for this well-known product. The Department of Agriculture, F.M.S. will not be in a position to supply suckers for some considerable time, as all its material is at present required for large scale experimental purposes. It is estimated that fifteen suckers can be obtained per plant annually and it it is hoped that the Department will be able, in time, to supply a large number for planting purposes. Suckers can be obtained from Manila at a cost of a $190/- gold, per thousand, and the Department can furnish addresses of growers. Manila hemp is now quoted at £31 per ton.

Roselle Fibre. *(Hibiscus Sabdariffa var altissima).*

The Roselle fibre plant is an annual shrub found in most tropical countries and is related to the cotton plant.

There are two varieties, *Hibiscus Sabdariffa var: Victor* and *Hibiscus Sabdariffa var: altissima.* The Victor variety is grown successfully here by Tamil coolies as a vegetable and the flower sepals also provide a good jam or jelly. The altissima variety is the plant from which fibre has been obtained. There are two races of this variety, a red and a green, both of which yield fibre.

So far only small scale experiments with Roselle fibre have been conducted. The work is in an early stage and no data are yet available on which to base an estimate of the probable profit per acre. Work is in progress to determine these and other points.

It is expected that information will be available shortly in the case of consignments prepared on one or two estates which have grown the crop on several acres of land.

The plant grows well in this country, as far as can be judged by small scale experiments; the lateral branches, when cut at the right age, that is when the plants are just commencing to flower, and when the branches should be over four feet in length, yield, by a very simple process of retting in stagnant or slowly-moving water for eight or nine days, a fibre which has been favourably reported on. The fibre is suitable for spinning, and its general appearance is good, its special feature being the length of its staple. If the branches are cut when too old the fibre is found to be matted and of inferior quality.

The fibre from the main stem is of inferior colour and appearance, while the staple is shorter on account of the breaking of individual fibres at the points where the lateral branches emerge.

The best method of cultivation requires to be worked out, involving preparation of the land, planting, planting distances, upkeep, manuring and rotation, and the costs of these operations.

As an annual it has possibilities as a catch crop in young rubber clearings. On rubber land of good quality soil and comparatively free from timber, two or more crops might be harvested, but it would be unwise to continue its cultivation after the rubber trees are about two and a half years old. Roselle grows to a height of from eight to ten feet and should not be planted within a radius of five feet from the young rubber trees. It has also been observed to be attacked and killed by *Fomes lignosus*.

The plant can be recommended as a minor crop in view of the fact that the fibre can be prepared so easily by hand labour and that machinery is unnecessary. The process of retting and cleaning the fibre could be economically undertaken by any small holder, but small areas would not warrant the introduction of a baling press which is essential in order

that packing and freight charges may be reduced to a minimum. This difficulty however, might be overcome by establishing baling centres. In areas of any size a baling press could be profitably installed.

Although the fibre is undoubtedly a valuable one, there will be difficulties at first in securing a market, particularly in the case of the small holder, but there is little doubt that when it can be offered in commercial quantities it will meet with a ready sale in the United Kingdom.

Kapok. *(Eriodendron anfractuosum.)*

Kapok (Malay Kabu-kabu) is the floss contained in the pods of the kapok or cotton tree which is found scattered in small numbers throughout Malaya.

Considerable quantities of kapok are exported from the East to various parts of the world; the principal exporting countries are Java and, more recently, the Philipines, while the principal importing countries are America, Australia and Great Britain. Amsterdam is the principal distributing centre for Europe. Enquiries made recently have shown that the greater part of the kapok used locally is imported from Java.

In early days, both in Java and the Philippines, the industry was entirely local and the trees, as in Malaya at present, consisted of scattered groups, grown by natives. Later, the industry was developed to a small extent as a plantation industry in Java and more recently in the Philippines although, owing to the comparatively small returns, the tree is not grown on land suitable for more remunerative crops, except as a subsidiary or secondary cultivation.

During the war, the demand for the floss increased considerably as it was found to be extremely valuable as a non-absorbent stuffing material in life-saving apparatus.

Climate:—The cultivation of the kapok tree requires a tropical or sub-tropical climate. The tree does not require a large rainfall and can withstand drought, while heavy rainfall and excessive damp during the fruiting season rot the pods and damage the floss. Strong winds are also detrimental in breaking the branches owing to the brittle character of the wood.

The climate of Malaya appears to be suited to its cultivation.

Soils ;—A wide range of soils appears to be suitable, although the best results are said to be obtained on soils of a volcanic origin. Alluvial soils, and both sandy and clay loams, if deep and well drained, are also suitable.

Although the kapok tree appears to thrive on comparatively poor soils, those of good medium fertility are preferable in order to obtain sufficiently high yields to compensate for the cost of cultivation and production.

Propagation :—The trees may be propagated from seed or cuttings. Propagation from cuttings is said to be easier and more commonly practised, while propagation from seed is said to produce healthier and more productive trees. On the other hand trees propagated from cuttings mature in from six to twelve months earlier than those grown from seed.

Cuttings taken from the branches should be three quarters of an inch to two inches or more in diameter and from half to two yards long They should be planted as soon as possible after cutting, preferably at the commencement of the wet season. About fifteen inches of the cuttings should be below the surface of the soil.

Seed should also be sown preferably at the commencement of a wet season ; the seeds should be sown about six inches apart in nurseries on a slope. The nurseries should be well prepared and kept free from weeds.

The seeds retain their vitality for a long period and germinate rapidly.

As soon as the seedlings appear, they should be shaded and the shade retained until the seedlings are about six inches high which will be in about twenty to twenty-five days from germination. The seedlings should be thinned out, leaving only the best plants.

Planting and Cultivation :—The seedlings may be transplanted into the field when about ten to twelve months old or after reaching a height of about thirty inches.

Transplanting should be done during the rainy season, and the seedlings should be lifted with as much soil as poss-

ible. Deep wide holes should be dug so that about six inches of fine loose soil is left under and round each plant. All leaves should be removed from the seedlings before planting in the field, and if the seedlings are between eighteen inches and five feet they should be cut back to the former height; if they are longer they should be cut back to about three feet. The soil round the roots should be kept loose during the first six to eight months.

If planted as a sole crop, the planting distance should be about eighteen feet by twenty feet or twenty feet by twenty feet.

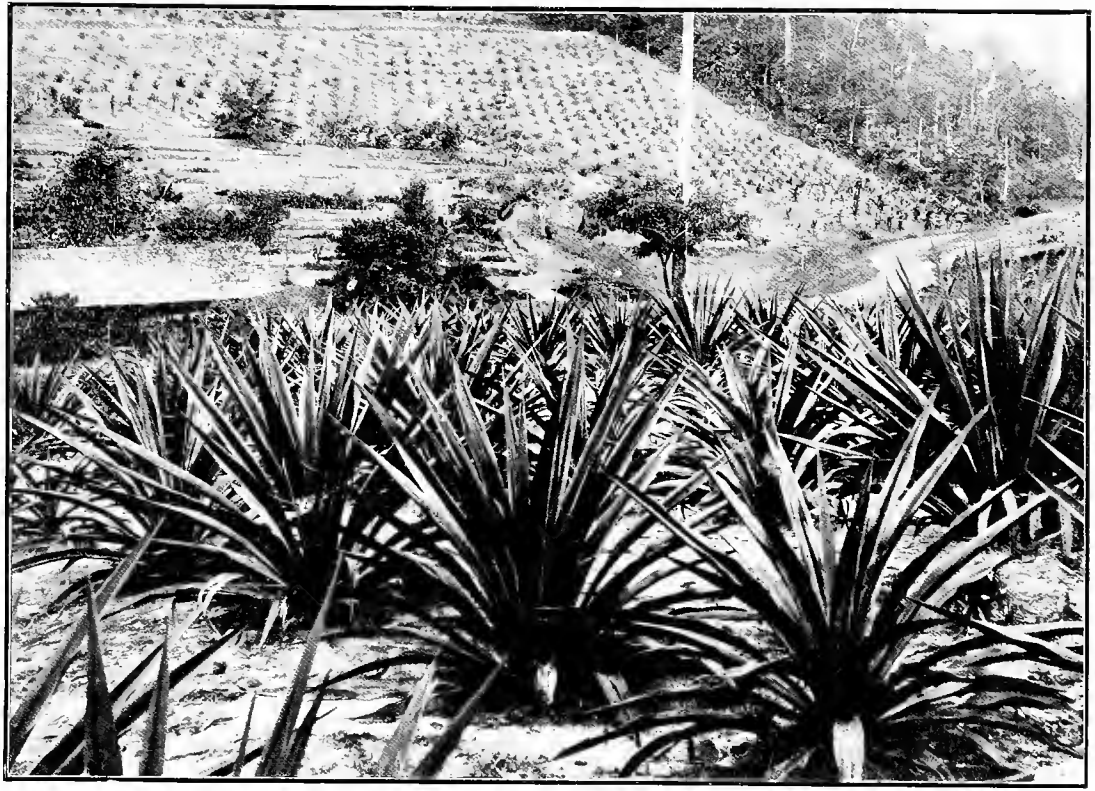
No cultivation is required, but a space round each tree should be kept free from weeds. If a catch crop or subsidiary crop is not grown, it is advisable to grow a cover crop, preferably a legume, in order to save cost of weeding and to maintain the nitrogen and organic content of the soil.

In Java, coffee, cacao, pepper, vanilla and sisal hemp plants are stated to be grown as subsidiary crops. Since the kapok tree provides little shade, such secondary crops can be grown permanently.

Crops and Yields:—The first crop is obtained within three to four years from trees grown from seeds and earlier, as stated above, from cuttings. The first two or three crops are small and normal crops are obtained from the sixth or seventh year and onwards, increasing till a limit is reached at thirty years or over. The pods, after they first appear, ripen within two to three months and pods on the same tree may be maturing during a period of two to three months, i.e. the whole crop does not mature at the same time.

When the green pods are ripe, they turn light brown in colour and the surface becomes wrinkled; they should be collected at this stage, since, if left longer on the tree, they open at the top, and the floss is exposed and discoloured.

Only ripe pods however should be collected, since the unripe pods contain an inferior floss, which is liable to ferment on storage. Over-ripe pods produce a floss with a dull lustre and of poor elasticity. The pods must not be allowed to fall from the tree, but should be collected by being cut off by means of knives attached to long poles, since it is not possible for coolies to climb the trees, owing to the brittleness of the wood. After collection any damaged pods should be separated and the pods opened quickly, since



MAURITIUS HEMP
at Kuala Lumpur Experimental Plantation

MAURITIUS HEMP AND YOUNG CINCHONA TREES
at 1,200 feet on Gunong Angsi, Negri Sembilan

the colour and lustre of the floss deteriorate if left in the pods. The opened pods, if damp, should be spread on a clean dry floor.

After splitting the husk or shell of the pod, it can be opened by squeezing with the hand and the core and woody walls of the valves are separated and the floss and seed removed together. Any damaged floss should be kept separate from the good material.

Preparation of Floss:—On a small scale, hand methods for separating the floss from the seed can be adopted. A bamboo frame with square holes sufficiently large to allow the seeds to pass through, is placed on a box or over the floor and the mass of floss and seed is beaten with bamboo forks or sticks, till all the seed has dropped through the frame. A better method is to place the floss with seed attached in bamboo baskets or hollow cylinders with perforated bases. A stick or piston is passed through the cylinder, and to the lower end of the stick is attached two pieces of wood in the form of a cross. The top of the basket or cylinder is covered and the stick or piston attached to a wheel or handle, so that the stick can be rotated. The cross piece attached to the stick or piston stirs the kapok and separates the seed, which falls through the perforated base of the basket or cylinder.

For large-scale operations, suitable cleaning machinery has been evolved, which is said to be simple, strong, cheap, portable, and effective. The general principle of all the different machines is a rectangular or polygonal box or chamber, set horizontally or vertically and having a shaft with blades attached on opposite sides, running the length of the chamber. The blades may be attached to the shaft opposite each other or alternating.

Similar blades are attached to the walls of the chamber, each blade being placed just in front of another blade on the shaft. In both cases the blades are removable and adjustable.

A fan may be also adapted to the machines to blow the floss into a chamber at one end of the machine, while the seed falls through the perforated base of the machine.

Three machines used in the Philippines are the Bley machine, the Becker Machine and the Sieman machine.

The first is said to clean about five hundered lbs. of floss

per hour requiring only half to one H. P. to drive it.

The Becker machine is similar to the Bley machine but constructed with a vertical chamber. It is stated to clean about two hundred and seventy lbs. of floss per hour.

The last named machine is said to be manufactured by an English firm and is a small machine, very suitable for small plantations, cleaning two hundred and seventy to three hundred lbs. of floss per day of ten hours.

Yields:—No very reliable figures in respect of yields are available. From trees under seven years old, three hundred and fifty to four hundered pods per tree per annum have been obtained and from trees betweeen seven and ten years of age, six hundred pods.

The yield of floss is also very variable but it is probably safe to estimate about 1 lb. per hundered pods

The yield of seed is about twice the weight of the floss; cleaned kapok varies however from fifty-five to sixtyfive per cent of the weight of seed.

The yield of seed is also variable.

Description of Fibre or Floss:—The fibre is short, light and brittle, its shortness and brittleness together with the straight and cylindrical character of the cells, as compared with the flat and twisted cells of cotton, render it unsuitable for spinning, although several claims have been made in this connection.

The cell walls of kapok fibre are also thinner than those of cotton, which renders it much weaker. Its lustre and elasticity however are marked.

Uses:—Kapok may be described as the premier fibre for stuffing or filling purposes in all upholstery work. Owing to its lightness and buoyancy and non-matting qualities after long use combined with its non-absorbent qualities in respect of water, it has also found extended uses during recent years in life-saving apparatus, life belts, buoyant cushions, etc.

Classification and Baling:—Kapok is sold in Amsterdam under two classes — cleaned and uncleaned, the former consisting of the pure fibre and the latter containing seeds and adhering core etc. There is, however, no special grading system. These two classes are subdivided as follows:—

Cleaned (1) Extra (2) Good (Prime Java) or First quality (3) Second quality (4) Damaged.

Uncleaned (1) Good or First quality (2) Ordinary or Fair quality (3) Damaged. The fibre is now usually exported in a cleaned state from Java, but both qualities are exported from the Philippines.

Since freight is based on the volume as well as the weight, baling is important, although the small holder could deliver his fibre to local dealers in sacks.

A rice sack will contain nine to eleven lbs. of fibre or one cwt. of seed.

A baling press with suitable pump is required for baling the fibre for export.

Bales are usually about ten cubic feet in content and weigh from 90 to 110 lbs. They may be covered with matting or sacking properly sewn together, and tied with steel or rattan bands.

Bye-Products:—The seed may be considered as a useful bye-product and closely resembles ordinary cotton seed, yielding 20 per cent of an oil very similar in character to cotton seed oil, and used in the manufacture of soap, and as an adulterant of other oils. The cake or meal, after expression of the oil from the seed, is a useful cattle food or fertiliser.

It would not be advisable to express oil on a small plantation except by means of a small Oil Expeller aud the seed after separation from the floss may be shipped in sacks.

Pests and Diseases:—Fungus diseases are unknown at present. The chief insect pest is *Dysdercus cingulatus,* similar to the cotton stainer, which attacks and damages the fibre. Bats and monkeys are also stated to be destructive.

Value:—The present market price of the fibre from Java is quoted in London at one shilling to one and a penny per lb.

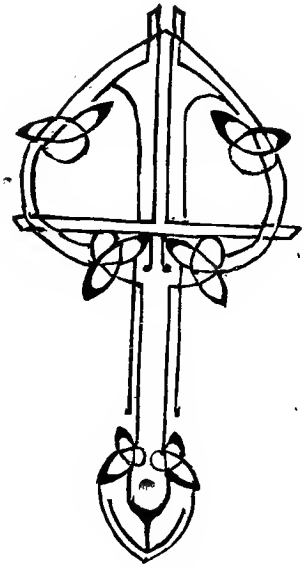
Inferior qualities from India and Ceylon fetch only up to one half this price.

Possibilities in Malaya:—This cultivation offers possibilities in Malaya if the plant is not grown on too large a scale

but under estate conditions, it would be preferably grown as a secondary crop or as the main crop with a secondary crop interplanted, as is done chiefly in Java.

Provided satisfactory arrangements can be made for collecting and marketing the fibre from small holders, it should prove an eminently suitable cultivation for such cultivators. Steps are being taken to encourage its cultivation among small holders and to arrange for the ginning and marketing of the fibre.

Enquiries are being made in regard to buyers and markets in other countries and also suitable machinery for ginning.



The Sugar Cane.

History of Sugar Cane Cultivation in Malaya.

Present Position and Possibilites.

CHAPTER X.

The Sugar-Cane.—(*Saccharum officinarum.*)

THE sugar-cane is a tall-grass or reed, reaching a height of from eight to twelve feet, and is found cultivated in all tropical countries. The chief countries in which it is grown on a commercial scale are Cuba, India, Java, Mauritius, Guiana, Hawaii, Philippines and the West Indies. The cane-sugar of commerce is obtained from the juice of the sugar-cane, although the sugar beet yields a similar product.

History. It is stated that sugar-cane was cultivated by the Chinese in Province Wellesley long before the colonisation of Penang, and cane-sugar was actually exported from Penang in 1805. Later the Malay Peninsula became one of the foremost sugar producing countries, sugar and coffee being the two principal crops grown on a commercial scale.

The principal areas under sugar cultivation were in Province Wellesley and Krian, but about 1901 its cultivation was extended to Lower Perak. All these areas were gradually planted with rubber, replacing the sugar-cane, and, except for small areas where it is grown for eating purposes, its cultivation has been abandoned.

Varieties of Sugar Cane. It is not possible in a brief article to give a description of the large number of exisiting varieties of sugar-cane, but it might be of interest to point out that some of the canes originally grown in this country, such as the "Selangore" cane and the "Red Purple" cane of Singapore, formed the stock from which a number of new varieties been developed. The two commoner varieties formerly cultivated in this country on a commercial scale were the "Red Ribbon" and the "Large Yellow" or "Bourbon" cane.

Soil and climate. The plant requires a hot humid climate, alternating with dry periods and thrives best on flat land at low elevations preferably situated on tidal rivers, which not only allow of proper drainage but also provide a suitable means of transporting the cane to the factory.

The most suitable soils are sandy loams, clayey loams and alluvial soils containing a fair proportion of clay. Light sandy soils, heavy clay, or peaty land are all unsuitable. Good surface drainage is essential as the plant cannot tolerate a water-logged soil.

Sugar-cane is a somewhat heavy feeder and manuring is necessary after the first or second crop.

Cultivation. The land should be thoroughly clean and free from weeds, changkolled or forked to a depth of six to seven inches until it is brought into a fine state of tilth and then made up into ridges five to six feet apart. If conditions are suitable tractors may be employed in ploughing and harrowing the land previous to planting.

Although any part of the cane containing two or three eyes or buds can be planted, it is the usual practice to plant only the top parts of the cane, which contain less sugar. The tops or cuttings, usually eight to ten inches in length, are placed in the furrows or ridges at intervals of two to three feet apart. They are planted in pairs a few inches apart in an oblique position in the ground, with only a small portion above the soil, which should be firmly pressed down. The old canes may be allowed to ratoon, that is, to grow up from the root-stocks in order to avoid replanting. This method, however, was found to be unsuited to this cuntry and only practised as a last resource when owing to shortage of time and labour it was impossible to harvest the cane and replant in the usual way.

The labour requirements for sugar cane cultivation are fairly heavy and it is estimated that at least one unit of Indian labour is required per acre, but this can be considerably reduced by employing mechanical power for cultivating and preparing the land for planting.

During the first six months after planting the soil must be maintained in a friable condition by forking and changkolling in order to allow the surface roots to develop.

Canes grown from cuttings usually take about twelve months to reach maturity, but if a second or ratoon crop is allowed to grow from the old roots it will mature in from nine to twelve months.

It is well known that some varieties ripen earlier than others, whilst climatic conditions may accelerate or retard the period of growth.

Yields. Shortly after flowering, when the canes become hardened and ripe, which can be seen from their general appearance, they should be cut as close to the ground as possible since the sugar content is greatest near the root. After cutting, the canes are tied into bundles and transferred to punts or bullock carts for transport to the factory.

Under favourable conditions the average weight of cane per acre from plants in this country is twenty five tons, yielding about two and half tons of raw sugar. A sugar content of twelve per cent and a recovery of ten per cent on the weight of cane would be a fair average for the types of cane previously grown in this country, but there is no doubt that by careful selection and breeding it should be possible to produce improved strains.

Manufacture. There are two methods of manufacture, one in which Vacuum Pan sugar is produced and the other in which a product known as Basket sugar is obtained. The former process is elaborate and expensive, whilst the latter is somewhat crude and requires less machinery, with the result that the product is less valuable. In both cases the first operation is to express the juice from the cane, and this should be done as quickly as possible after the canes are cut, as the juice is normally acid and fermentation which lowers the content of sucrose or crystallisable sugar, sets in very quickly.

The canes are passed longitudinally between heavy crushing rolls, and this either crushes or macerates the cane.

With ordinary metal rollers it is possible to extract about eighty five per cent of the juice in the cane, but with modern machinery as much as ninety to ninety five per cent can be extracted.

The fibrous material left after the extraction of the juice is known as "Megass" or "Bagasse" and is used as fuel for raising steam for the evaporating pans and for power purposes in the mill.

Vacuum Pan sugar is prepared by subjecting the juice to a series of processes, the main object of which is the arresting of fermentation by heating, the counteraction of acidity by the addition of lime, discolourisation of the counteraction of the juice by boiling under reduced pressure in a series of vacuum vessels, granulation in a single vacuum vessel by further evaporation, and the separation of the grains of sugar from the molasses or uncrystallisable constituents in centrifugal machines.

Molasses consisting chiefly of sucrose (crystallisable sugar), glucose (uncrystallisable sugar) and water is a valuable bye-product from which rum is manufactured. Molasses is now also used as a source of power-alcohol,

In the manufacture of Basket Sugar, the cane juice is neutralised in the ordinary way and boiled in open tanks or pans to a certain consistency, the scum being removed at intervals as it forms. The thick liquid is then run into shallow wooden trays, stirred and cooled quickly, when the mass will form into grains resembling fine sand. It contains all the impurities present in the juice and yields no bye-products. The above is only a very brief and broad outline of the process of manufacture. Modern sugar factory practice is highly organised under scientific control.

General. When the cultivation of sugar-cane was formerly carried on in this country sugar was produced at a profit even with the local price of Basket Sugar as low as $6/- to $8/- per picul. This was only possible with the system of indentured labour and the low rates of wages in force at that time.

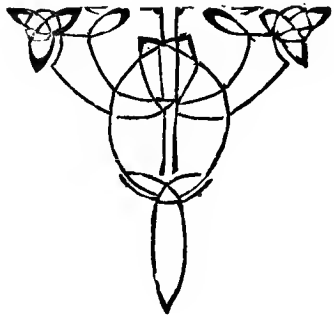
It is estimated that under present conditions the actual cost of production would be about $12/- per picul or £25 per ton which leaves little or no margin of profit.

Providing costs of production could be reduced by cultivating improved strains giving a higher yield and by the employment of machinery in the cultivation of the land it might be possible to resuscitate the industry.

The production of large quantities of beet sugar in Central Europe, however, will always tend to keep down prices and this factor should not be overlooked when the cultivation of sugar-cane is under consideration.

With a view to encourage the cultivation of sugar-cane in Malaya, the Government of the Federated Malay States is prepared to consider applications for land for this purpose on specially favourable terms in respect of rent and export duty on sugar.

The Department of Agriculture has recently made a comprehensive collection of the principal varieties of local sugar-canes and experiments are now being carried out to ascertain their relative values for cultivation on a commercial scale. Further, it is intended to conduct selection and breeding experiments with these and other varieties, which may be imported from time to time, with a view to obtain improved strains which will give higher yields and be more resistant to disease.



Miscellaneous Crops of Economic Importance.

Gambier.

Tuba Root.

Tobacco.

Betel Nut.

Gutta-Percha.

Sago Palm.

Tapioca.

Coffee.

CHAPTER XI.

Miscellaneous Crops of Economic Importance.

Gambier.—(*Uncaria Gambier*)

GAMBIER is a tanning material obtained from the leaves and twigs of *Uncaria Gambier*, which is a large climbing shrub, indigenous to Malaya.

Its cultivation in this country has always been in the hands of natives, the export of gambier being made, almost exclusively, by the Chinese.

The following are the exports of gambier from the Federated and Non-Federated Malay States for the past two years :—

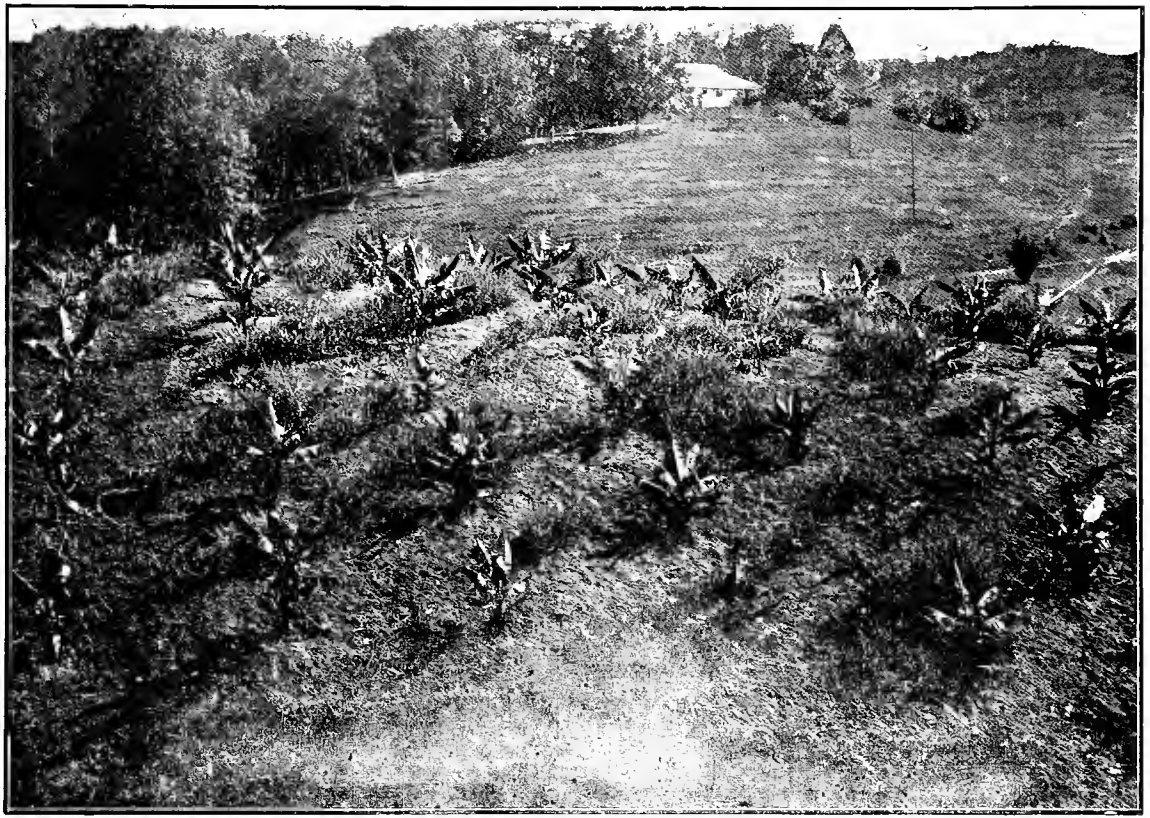
	Federated Malay States.		Non-Federated Malay States.	
	Quantity. Pikuls.	*Value.* $	*Quantity.* Pikuls.	*Value.* $
Gambier in Bales, 1919	1.294	18,628	70,028	974,976
„ Cube „	5,384	117,334	3,855	83,410
Totals	6,678	135,962	73,883	1,058,386
Gambier in Bales, 1920	704	11,461	43,218	545,091
„ Cube „	5,157	97,893	4,025	72,472
Totals	5,861	109,354	47,243	617,563

The principal countries to which it is exported are the United States of America, the United Kingdom and France.

Cultivation :—The plant is propagated from seed which is sown in nurseries. The seed deteriorates rapidly and in order to ensure good germination, great care must be taken to obtain fresh seed. One pikul of seed will produce sufficient seedlings to plant one hundred acres. The nursery beds should be shaded and the young plants carefully watered during dry weather. When the seedlings are about three inches high, which is at the age of five to six months, they are ready for transplanting in the field. Transplanting should only be carried out during wet weather, otherwise it will be found difficult to establish the plants. The most suitable distance of planting is 6 ft. x 6 ft. or 1,210 plants per acre. After transplanting little or no cultivation beyond ordinary surface weeding is required, but careful attention must be given to supplying and any dead plants should be replaced by fresh seedlings from the nursery.

Harvesting :—The crop which consists of the leaves and young branches may be first collected at about fifteen months from the time of planting and further croppings repeated at intervals of four to six months according to the condition of the growth ; should a period of drought follow the pruning, the plants take much longer to recover than when pruning is followed by rain. The prunings which are from one to two feet long, should be selected from the side branches and never from the main shoots. The number of shoots cut from each plant varies considerably and only the most vigorous shoots should be selected. Under suitable conditions cropping may be continued for a period of about ten to twelve years, when the land is allowed to become fallow and to grow up in blukar.

Extraction :—The manufacture of gambier is very primitive, the product being obtained by boiling the leaves and shoots in water and concentrating the extract so produced until it solidifies on cooling. The boiling process is carried out in large deep pans over open fires. The solid extract is cut up into small blocks and placed on racks under cover, where it remains for seven to ten days until quite dry. These blocks are then pressed together, packed in grass matting and covered with gunny sacking, each package containing about half a pikul of gambier. This is marketed as gambier in bales and does not fetch such a high price as cube gambier. The latter requires more attention in its preparation and is free from foreign matter, of a



MANILA HEMP WITH THE GIANT MIMOSA (*Mimosa invisa*)
as a cover-crop at the Kuala Lumpur Experimental Plantation

COLLECTING THE NIPA SAP

NIPA PALMS IN FRUIT

much better colour and, being cut into cubes an inch square, is much drier than the crude product sold in bales.

Yields:—With regular prunings from plants grown on good soil a yield of eight to ten pikuls of dry gambier per acre per annum should be obtained.

The present prices (January, 1922) for Gambier are $9/75 per pikul in bales, and $15/- per pikul for No. 1 cube, unpicked, this leave practically no margin for profit. With the cost of production at about $8/- per pikul the price of ordinary Gambier in bales should be at least $12/- per pikul to make its cultivation remunerative.

Uses:—Gambier is an important tanning material, giving a peculiar gloss to leather which is not produced by other tanning substances. It is also used extensively as a dye in the silk trade.

Tuba Root. (*Derris elliptica Benth).*

The roots of 'tuba' possess toxic principles which may be utilised as a stomach poison and contact insecticide against certain insects injurious to plants.

Results of investigations made recently at the Rothamsted Experimental Station, Harpenden, England, which will be published shortly, have shown that the material is of a satisfactory order of toxicity to caterpillars and to have fairly good prospects as an insecticide.

The insecticidal properties appear to depend on the fineness of division of the toxic particles and on this account the aqueous emulsions of the fresh root may be expected to show toxic properties greater than those of the old dried material, in which those particles have had time to coalesce. No definite information is available as to the keeping properties of the emulsions, but such emulsions have been kept for a month in England without material loss of toxicity.

The poisonous principle can be extracted by such solvents as benzene, coal tar, naphthalne and carbon tertrachloride, while the poison and some non-toxic material is also extracted by alcohol.

Petroleum derivatives are of little use for extraction as they only imperfectly dissolve the toxic resins.

The question remains to be decided therefore, whether there would be any advantage in exporting an extract rather than the ground or unground root.

Chinese gardeners, although appreciating the value of tuba root, grow it on a relatively small scale, mainly for the purpose of providing an insecticide for use in their vegetable gardens. Considerable quantities of the dried roots are used in the manufacture of certain insecticides, and, judging from enquiries received from England, it would appear that there is a growing demand.

The cultivation of the plant presents no difficulties and as it is amenable to light shade, there is no reason why it should not be grown as a catch-crop amongst rubber or coconuts.

Cultivition:—Tuba may be propagated readily by means of stem cuttings, eighteen inches long, planted in sandy soil. If exposed to the full sun, it is advisable to remove the leaves to prevent the stems dying from excessive evaporation. Under light shade, the cuttings root earlier, often within six weeks from the date of planting.

Chinese market gardeners appear to be the only persons at present cultivating this crop. The method of cultivation adopted is to plant long cuttings that have been twisted up into a circle, at a distance of about six feet apart, and allow the plants to ramble over the land. During growth, pig manure is applied to the soil. The crop is not harvested as a whole but roots are lifted as required.

As a sole cultivation, the best results are likely to be obtained by ridging the land. The ridges should be made three feet apart, the soil being worked into a fine tilth during the operation. Tuba will grow in most soils but is partial to a clayey loam containing a fair quantity of sand. The cuttings should be placed on the ridges at a distance of three feet apart, giving 4,840 plants to the acre.

The time that the roots take to reach maturity varies according to cultural conditions, the average period of growth being two years. The weight of fresh roots obtained from a single plant varies from one to three pounds. The average weight of roots per plant obtained on the Experimental plantation, Kuala Lumpur, is one pound and a loss of weight of forty per cent takes place upon drying.

The retail price of the root in the local market at the present time is about fifty cents per kati. The value of the root for export is variable. One quotation recently received was placed at 8¼ d per lb. F. O. B., Port Swettenham, allowing 20 per cent for loss of moisture.

Tobacco.

Apart from small areas planted by Asiatics (usually by Javanese) tobacco is seldom cultivated in Malaya. Such tobacco as is produced is generally of a poor type, and is prepared for smoking without regard to fermentation.

With a view to stimulate interest in this subject, and to judge the possibilities of tobacco production in Malaya, the Department of Agriculture carried out a series of experiments in 1917. The report on these experiments will be found in the *Agricultural Bulletin F.M.S.* Vol. VI No. 6. The writers of this report thus summarised their conclusions regarding the possibilities of successful cultivation and marketing :—

"The progress thus far made in the introduction of tobacco seed into this country does not indicate in any way that the crop is suitable as a main crop for European planters, nor in fact that it would be suitable for such planters to grow even on a small scale ."

"The trials on tobacco growing here described point to the fact that, by natives, tobacco may be grown of better quality than the varieties at the present time cultivated by them, and undoubtedly yielding a greater quantity of leaf."

The first conclusion possibly needs some modification. At the moment, rubber is less in favour than it was in 1917, and planters are more prepared to consider other crops than they were at that time. It must be remembered too, that the import duty into this country has doubled since the writing of the above mentioned report. The following are the present duty rates on tobacco.

Cigars and Snuff	... ...	$ 1.20 per lb.
Cigrattes	... ...	0.80 „ „
"Native" tobacco(from Java,Sumatra etc).		$20.00 per pikul
Leaf	... ...	$20.00 „
Other tobacco	... ...	0.80 per lb.

The cultivator of tobacco in this country would therefore be protected to the extent of the above duties.

There is a ready local sale for low-grade tobacco, suitable for native consumption. Such tobacco requires the minimum amount of preparation after harvest. Javanese in this country state that they produce about three and a half pikuls of tobacco per acre, which they are able to sell at from $90—$110 per pikul.

Doubt has been expressed in some quarters as to whether producers of tobacco would have difficulty in disposing of their crop. It can only be said that the Department had no difficulty in selling tobacco in leaf, obtained from the experimental plots, to local native buyers.

At the present time there is no evidence that high grade tobacco production (i.e. leaf suitable for the European market) would prove profitable in this country, but there is every reason to suppose that, given good soil, crops of tobacco can be profitably grown for local consumption.

Should the grower propose to attempt the production of tobacco for the English market, a venture, which, if successful, would give greater profits, we would quote from a recent letter from a buyer in England.

> "For tobacco other than Cigar leaf there is a considerable market here (which is greatly helped by the preference duty on all Empire grown tobaccos) for two distinct types of tobacco, one a bright, mild, free burning Virginia type of leaf, as near lemon colour as possible and the other grade a thick, dark, heavy bodied, leathery tobacco."

The duty on import of tobacco into England is 8/2 per lb. and 6/10 per lb. on colonial grown tobacco.

The Department is in a position to place growers in touch with English and American buyers and will be pleased to give further advice and instructions on this question.

Betel Palm, *(Areca Catechu).*

The betel or areca nut palm which is a native of Malaya, is a graceful tree with a straight unbranched stem reaching 40 or 50 feet in height and about 1¼ feet in circumference, bearing a crown of from six to nine very large spreading pinnate fronds.

The betel nut is used extensively as a masticatory in the East. It has been estimated that one tenth of the whole human family indulge in betel chewing. It is said by those

addicted to the habit, that it strengthens the gums, sweetens the breath and stimulates the digestive organs,

Betel nuts are of use at the present time chiefly as a drug and masticatory and are also said to be used in various tooth pastes. They are said to have excellent properties as a vermifuge.

Although there is a large number of betel palms growing in the Muar district in Johore, the betel nut industry is now slowly dying out, owing to the native preference for planting rubber.

In a very few cases the betel nut plantations are being run by the original owners or planters, who were mostly Malays. The commonest system is to hire out the plantation on contract, usually to Chinese, who collect and sell the fruit.

Only virgin jungle land is planted with betel nuts; it is stated that if other land is planted, the palms make poor growth and yield very little fruit.

The palms are usually planted about eight feet apart each way, on the square system giving six hundered and eighty trees to the acre. Very little weeding is done and there is always a fairly thick undergrowth of lalang etc. The land is never manured or cultivated, in fact the plantation is allowed to look after itself, until it reaches maturity. Little trouble is experienced with pests and diseases.

The palm bears flowers and fruit after the fourth or fifth year and continues to yield for fifteen to twenty years. As each leaf dies and falls off, it discloses a swollen leafy sheath in the axil. This sheath quickly ruptures and sets free the inflorescence, which is composed of a large number of small palish flowers. The time required from the first appearance of the inflorscence to the ripe fruit is about six months.

The young palms bear from two to six bunches of fruit per year, while older palms bear one or two bunches a year and finally do not fruit at all. All the bunches of fruit do not appear simultaneously, but the young palms may have fruit and inflorescence in different stages at the same time.

The fruits are collected when ripe. They then consist of a thick outer husk of coarse fibre enclosing the nut. The fruit must be thoroughly dried for the market. It is very

difficult to separate nut from husk when the fruit is newy, gathered, but when dry, the husk is removed quite easilly The natives have various names for the finished product according to the method of preparation.

Pinang blah ;—In the preparation of " Pinang blah " the fruits are split in two parts and spread split side upwards, on an open space in the sun. The nut is removed easily after two or three days. Care must be taken to protect the fruits from rain, otherwise their value will be decreased. The husks are burnt by those who prepare " Pinang salai." The nuts are thoroughly dried and put up in sacks for the market. Most of the nuts in the Muar district are prepared in this way.

Pinang mossi :—The fruits are placed in heaps to dry, the heaps are turned occasionally during three months, by which time the husk is easily removed ; the nuts are then dried and packed, but are inferior in quality to " Pinang blah."

Pinang salai :—" Pinang salai " is a smoked preparation of betel nut. The fruits are placed on a bamboo grating with mud sides. A fire of old betel nut husks is made under the grating ; this smoulders, giving off a large quantity of smoke, which escapes through the grating and thoroughly smokes the fruits. After about five days the nuts can be removed from the husks, and are then dried for a couple of days in the sun, when they are ready for sale. These smoked nuts fetch the best price.

Pinang asin :—" Pinang asin " is obtained by placing unripe fruits (green) mixed with salt in sacks for two or three months ; very little of this preparation is made in the Muar district.

The average number of fruits to a bunch is about two hundred, so that on the average, a palm produces six hundred fruits (three bunches) per annum. These six hundred fruits produce seven and a half katis of dried nuts. With six hundred and eighty trees to the acre, the yield of prepared nuts should be fifty one pikuls per acre per annum. The present local market price is eighteen to twenty cents a kati.

The export value is at present about $9/- per pikul.

Gutta-Percha.

Gutta percha is now cultivated under plantation conditions and it may be considered as an agricultural industry.

The product known as gutta-percha is obtained from several East Indian trees of which *Palaquium oblongifolium*, known to the Malays as 'taban merah,' and *Palaquium obovatum*, 'taban puteh,' are the most important. The gutta from 'taban merah' is much superior to that from 'taban puteh'.

'Taban merah' occurs naturally in the Malay Peninsula, Sumatra and Borneo; it has been introduced into Java where 2,500 acres have been planted. The tree is found in varying numbers in many parts of the Federated Malay States and occurs in large forests in several districts. The Forest Department controls the natural supplies of taban and the systematic improvement of taban reserves is an important part of the work of that department.

The cultivation of 'taban merah' is beset with several difficulties, the principal being an insufficient supply of seed. Seed is not easily obtainable in large quantities and deteriorates rapidly, losing its germinative power in about two weeks. Taban does not produce seed until at least fifteen years old. The method of cultivation as adopted in Java and this country is as follows :—

The seeds may be sown either in shaded nursery beds or germinated in moist sawdust and planted out at stake. The latter system is the more satisfactory, provided the weather is suitable. Two seeds are planted in each hole and protected with a lalang cap. The distance of planting adopted in Pahang is six feet by five feet; in Java the usual distance is stated to be four feet by four feet. Seedlings may be planted out when eight months old and should be shaded during the fiirst six months of growth. Should the seedlings remain longer in the beds, they may be lifted when one and a half years old during suitable weather and planted out as stumps.

Pruning is an important operation in taban cultivation. The trees are pruned when two years old, allowing each tree three lateral branches. The object of this pruning is to give the young trees a bushy habit, by increasing the lateral spread of the branches.

Methods of extraction:—As a jungle product, the latex is usually obtained by tapping. In estate practice the leaves are plucked and the gutta extracted by crushing. Information regarding the yield of green leaves per acre is variable. The first plucking should give three thousand lbs. of leaves, gradually increasing to a maximum of ten thousand lbs.

The yield of gutta is given as 1.5 per cent to 1.8 per cent of the freshly picked leaves. The leaves are chopped up in a machine while in a fresh state, and then crushed between rollers. The pulp obtained is treated with boiling water for the purpose of separating the dirt and refuse from the gutta. This process is repeated several times, when the gutta is removed and pressed into blocks.

The cultivation of taban is intricate and costly, but it appears to be a profitable planting proposition. The demand for gutta-percha at the present time considerably exceeds the supply.

For a useful account of gutta-percha, see *Agricultural Bulletin, F. M. S.*, Vol. v. No. 2, p. 25.

The present market prices (January, 1922) of raw gutta percha in Singapore are as follows:—

Fine Red	$540/- per pikul.
Lower qualities.	$220/- to $340/- per pikul.

Sago Palm.—(*Metroxylon Sago.*)

The Sago palm thrives exceedingly well in Malaya and may be found throughout the country, though it is perhaps most plentiful among the padi lands and the low-lying lands owned by Malays near the Perak River, and in the Kuala Pilah District, Negri Sembilan, where nearly all the native houses are roofed with the sago attap.

It is a pinnate leaved palm thirty to forty feet high, with a short cylindrical and usually recumbent or creeipng trunk.

This palm is indigenous to the Malay Archipelago. Practically all the sago prepared in Singapore is imported from the surrounding islands. The following import figures are of interest:—

	1911 Pikuls.	1915 Pikuls.	1919 Pikuls.
Sago Flour	709,444	806,651	841,727
Raw Sago	213,942	166,055	194,962

Of the above quantities only 30,870 in 1911, 9,018 in 1915 and 15,288 in 1919 came from the Peninsula (Johore).

This palm is useful on account of the fact that after it has grown for about five or six years, the leaves may be cut and used for making attaps. A few years later the tree may be cut down and the pith extracted from the stem, and used in the preparation pearl sago, sago and sago flour.

The sago palm grows best in marshy land on which it is almost impossible to grow any other tropical crop, with the exception of padi; it will even grow in many places where padi has been tried repeatedly without success.

The attap from this palm is much superior to that produced by the Nipa palm, since it lasts longer; a good proof of this statement is that it will fetch a higher price.

Propagation:—Sago is usually propagated by means of suckers, but this method is not satisfactory and is costly. Experience shows that, unless the suckers are most carefully taken from the parent tree, and this is very seldom done, they will not survive after being planted out; suckers are generally very expensive to procure, especially if transported any distance, and the results are most disappointing.

There are two varieties of the palm, "Spiney" and "Smooth". This leads to a difficulty when growing from seed, as the seeds are sometimes "cross-breds," so that although they may be taken from one type they may not all breed true. This difficulty is however, easily overcome by selecting the seedlings when planting out.

The advantage to be gained on the other hand by propagating the seed in nurseries, and afterwards planting out the seedlings when about 12 or 18 months old, is very great; for not only does it mean an immense saving in expense, but the results themselves generally prove to be far more satisfactory.

Care should be taken in the selection of seeds, which can be purchased very easily. Seeds should be planted out about one foot apart on slightly raised land, prepared in a similar manner as for padi nurseries.

Planting and Cultivation:—The cultivation of the palm is simple; in opening up the area the secondary growth of low forest and "blukar" should be cut down and burnt off as far as possible. The holes for the suckers or seedlings should then be dug out not less than fifteen feet apart each way and filled in again as soon as planting is finished. If the

ground is very swampy or likely to be flooded for a short time, plants should be a little over 18 months old when planted out. The roots of the plants should not be disturbed more than necessary when planting, and all roots should be properly covered in at the time they are being placed in the holes.

For one and a half to two years the plants should be circled round from time to time, the grass cleared up and the "blukar," if grown up, should be cut down and cleared sufficiently to prevent it interfering with the growth of the palms,

After this period, the condition of the land being favourable, the plants should make good progress without further attention.

In a properly managed sago swamp, with palms at the above distances, by leaving one sucker to replace each palm cut, the ground should be continuously productive, without much, if any, replanting.

Mature stems are bought by the Chinese for $2—$3 per stem for the manufacture of pearl sago.

Harvesting and Preparation of Sago:—The tree is cut for sago production when it commences to flower (when about ten years old); the trunk is cut into pieces three or four feet long and these pieces split in two. The starchy pith is then extracted and reduced to a powder, out of which the starch is washed and dried. The granulated sago is made by moistening the starchy meal till it forms a paste and passing it through a sieve, after which it is dried in ovens or the sun.

The natives of Malaya chiefly cultivate this palm for the sap from which palm wine (toddy), spirit (arrack), sugar and vinegar are prepared, eating the meal in the form of pottage or biscuits.

There is said to be a great demand in China for the reticulated fibres from the sheaths for caulking boats.

The total cost of production would be about $2 per pikul.

In addition to the above may be added the value of attap produced, but interest on cost of factory and allowance to meet depreciations of factory must be provided for. Owing to the amount of these two latter charges, it is not economical to build a factory for less than a 1,000 acre plantation.

Tapioca. (*Manihot utilissima*),

Tapioca or cassava, a native plant of Brazil, is cultivated in all tropical countries for its large tuberous roots which are either used directly as food or for the manufacture of the several forms of tapioca of commerce and starch.

The following figures show the exports of tapioca from the Federated and Non-Federated Malay States during the last two years.

	Federated Malay States.		*Non-Federated, Malay States.*	
	Quantity Pikuls.	*Value* $	*Quantity* Pikuls	*Value.*
Flake, 1919.	6,896	103,494	102,019	1,445,077
Flour „	5,142	21,244	57,621	391,648
Pearl „	7,652	132,780	84,354	975,904
Total.	19,690	257,518	243,994	2,812,629
Flake, 1920.	3,147	26,029	98,327	913,977
Flour „	1,994	12,480	33,301	277,308
Pearl „	6,108	68,002	71,552	582,029
Total.	11,249	106,511	203,180	1,773,314

The whole of this is exported to Singapore and Penang where it is re-exported. The principal countries to which it is exported from Singapore are (a) Flake to The United Kingdom, France and the United States of America (b) Flour to Hongkong, British India and Burma, French Indo-China and the United Kingdom and (c) Pearl to British India and Burma, the United Kingdom, Australia, New Zealand, Canada, Hongkong and Denmark.

Planting and Cultivation :—Tapioca is propagated from stem cuttings, which are planted three feet apart. The cuttings should be five to six inches in length and are planted in a sloping direction. The stems are generally made up into bundles, each containing twenty pieces from four to five feet long, the usual price being fifteen cents per bundle; about twenty of these bundles are required to plant an acre. The cost of planting is from $4.50 to $5/- per acre.

Apart from ordinary weeding little or no cultivation is required after planting,

There are two distinct varieties of tapioca, white and red, but the former takes longer to mature and is very seldom grown except on a small scale.

Harvesting and Yield :—The first crop is ready for harvesting at fifteen to eighteen months from the date of planting, and under fairly good conditions should yield from one hundred and twenty to one and hundred fifty pikuls of roots per acre. The second crop, which is planted up almost immediately after the first crop is removed, usually matures a little earlier, about thirteen to fifteen months after planting, and yields only eighty to one hundred pikuls of roots per acre.

It is estimated that one hundred pikuls of roots will yield fifteen pikuls of flour, but the percentage of flour decreases if the crop is over-ripe at the time of harvesting. In cases where the supply of mature roots is insufficient to keep the factory working it is a common practice to harvest roots which are not fully ripe and which would normally be allowed to grow for a further two months. The yield of root in such cases is naturally smaller than when the plant is allowed to reach maturity. About one hundred pikuls per day are required to keep a factory of the usual size in regular work.

Manufacture :—The processes of manufacture of the commercial products are fairly simple. The roots are first passed through a washing machine, very large ones being cut in pieces beforehand. They are then transferred automatically to a hopper leading to the pulping machine which contains graters revolving at a high speed. The grated pulp is carried away in a stream of water and passed through a sieve, which consists of hexagonal framework covered with fine silk cloth mounted on an axle at a slight inclination. The fine starch passes through the material of the sieve with the water and is run into settling tanks while fibre and other debris is discharged at the lower end of the sieving apparatus. After settling, the clear liquid is run off and fresh water added, the starch being stirred with paddles. This operation is repeated several times until all foreign matter has been removed, the starch being allowed to settle in the tanks of fresh water. The wet compact mass of starch is then broken up or rubbed through a coarse sieve, heated in shallow iron pans over open fires for a short time, and then placed on heated tables until thoroughly dry, when it is ready for the market.

The three common grades of tapioca which are manufactured locally are (1) flour (2) flake or granulated and (3) small and medium pearl, but there is no doubt that a large quantity of fine pearl tapioca finds its way into the local market under the name of sago.

Uses:—The tubers are used as a food by natives; the fresh young root being ground up and made into meal or bread as a substitute for rice. The tapioca of commerce obtained from the roots, as described above, is used as a foodstuff and for the production of starch and glucose. It is also used for sizing yarns and fabrics and for the manufacture of dextrin. The roots are also considered to be a possible source of power alcohol, and their utilisation for this purpose is described in an article in this Handbook on Power Alcohol.

General:—The market value of tapioca is very low at the present time and its cultivation cannot possibly be carried on profitably at such a low level. The local prices now ruling (January, 1922) are:— small flake $ 6.50, small pearl $ 7.25 and medium pearl $ 7.50 per pikul respectively, which are not considered sufficient to pay expenses. At present the cultivation and manufacture of tapioca on an estate scale is carried on entirely by Chinese.

Formerly there were several well known European estates which cultivated this product, but the cultivation of tapioca is not likely to be increased to any extent, unless it is found profitable at some future date to produce industrial alcohol as a fuel at a price which will enable the alcohol to compete with petrol or other liquid fuels.

Liberian Coffee.—(*Coffea Liberica.*)

The Liberian coffee plant is a strong growing species, native of West Tropical Africa, and introduced into Malaya and Ceylon. It grows naturally to the height of about twentyfive feet, if not pruned; its leaves are thick and large, the berries are comparatively large, and do not drop when ripe or become soft, remaining hard and fibrous. The permanent skin of the berry is comparatively tough, so that in cleaning it requires extra labour.

The best and steadiest crops of this coffee have been grown on land of a peaty nature in low country. If cultivated on hilly land care must be taken to avoid excessive surface wash. The seeds should be carefully selected from berries that have been perfectly ripened. After the seeds have been

completely separated from the pulp, they should be mixed well with dry ashes, and spread out in the warm place but not exposed to the direct rays of the sun.

Planting and Cultivation :—Seeds should be planted about one inch deep, and top dressed with fine soil after heavy rain, spaced at five or six inches apart under heavy shade, which is reduced as the seedlings develop. Seedlings should be planted out fifteen feet apart each way, when they have four pairs of leaves, including the " fish leaf." Planting out must be carefully done as the tap root must not be bent; if it is too long to plant easily, a portion should be cut off with a sharp knife. When about six to eight months old suckering will be necessary, and the one stem which is to remain must be carefully selected. Seed at stake, if carefully selected, will also give excellent results. The plants should be topped when they are about five and a half feet high, and carefully pruned, so that there is only one main stem and the bush kept round, the lateral branches not being allowed to be too close. In all cases where coffee is being pruned, it should be done with a very sharp knife, so as to leave a clean surface, which should be on the slant. If the branch or stem is thick, it should be tarred to prevent damage by water, insects or fungoid diseases.

Crop :—The period from blossom to crop is roughly ten months, and there are two crops during May or June and December or January. Ten pikuls of berries produce one pikul of market coffee. This variety of coffee does better in this country when it is grown without shade, especially as there is no suitable leguminous tree known which could be utilised for shade purposes.

The seedlings often suffer badly from attacks of leaf disease (*Hemileia vastatrix*) while in the nurseries, but usually recover completely when planted out into the field.

Coffee Robusta.—*(coffea robusta.)*

The Robusta coffee plant grows more rapidly than Liberian; its lateral branches are longer, gourmandisers and suckers are fewer, leaves are a lighter green, and thinner and larger in size; the berries are much smaller, but the beans are almost the same size, and there are more berries to a cluster, often over sixty. Four pikuls of berries yield one pikul of market coffee. The plant thrives best on a loose clay-loam soil.

Nurseries :—Nurseries should be on level, virgin jungle soil; if among rubber, the rubber trees should not be more than one year old.

Carefully selected seeds should be planted out 10 inches apart, under shade about 6 feet high, which is gradually thinned, till the plants have four pairs of leaves, when they are ready to plant out.

Planting and Cultivation :—Distances for planting in the field depend on whether the crop is grown as a sole crop or as a catch crop, but are usually about 8 feet x 8 feet. It is necessary to keep this crop clean weeded.

The bushes should be topped when they are at the most 8 feet high, but if done at the height of 6 feet, collection of the berries is facilitated. It is usual with this variety to allow one or two shoots to grow up.

This crop does not require shade for the first two years, but later on it is desirable.

For this purpose "lamtoro" *(Leucaena glauca)* is used, if coffee is grown as a sole crop, being planted the same distance apart as the coffee. The leaves of this shade plant are also useful as a green manure, for which purpose it may be planted closely in rows between the coffee, the leaves being cut every three months or so and spread between the coffee plants. The yields are very variable as indicated below.

	On virgin soils.	On old plantations.
1st year	—	—
2nd year	A little	—
3rd year	5. cwt	3 cwt.
4th year	8. cwt or more	5 cwt.
5th year	8. cwt or more	5 cwt. or more.

This variety is much less susceptible to the Leaf Disease *(Hemiliea vastatrix)* than others, unless it is grown under unfavourable conditions.

The American Leaf disease *(Cercospora Coffeae)* frequently attacks the seedlings, but it can be eradicated usually by spraying with Bordeaux mixture.

Arabian Coffee. (*Coffea Arabica*).

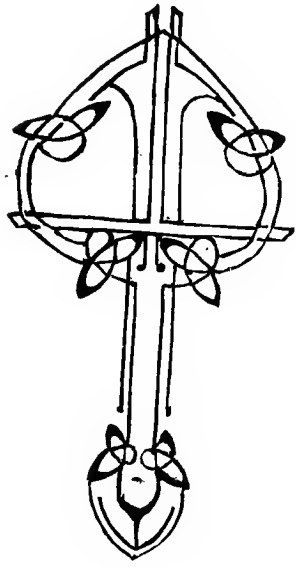
The Arabian coffee plant is a small tree, native of tropical Africa, but introduced into all tropical countries and cultivated extensively in Brazil, West Indies, South India, Java, etc. This coffee is generally cultivated at elevations between two thousand and four thousand five hundred feet, while the Liberian variety is best suited to low elevations the exact altitude being controlled to a large extent by' latitude. The temperature best suited for Arabian Coffee would appear to range from 55° to 80° Fah The total rainfall should not exceed one hundred and fifty inches, but about one hundred inches is the optimum. It thrives best on a deep loam soil though certain clays mixed with sand give good results, especially if a fair amount of humus is present. Low-lying and damp situations induce disease.

Nurseries:—The preparation of a nursery is important. The site of the seed bed should be on virgin land and the soil rich in vegetable matter and retentive of moisture. The beds should be slightly raised. Provision should be made for shade against the severity of the sun, but drip from protecting trees must be avoided. The importance of careful selection and the source of supply of seed cannot be over-estimated. The reputation of the seed estate, the age of the parent stock, the method of treatment of seed, are points of vital importance. The seed should be collected from healthy plants; the cherries which should be fully ripe before being plucked, are hand pulped after maturity and lastly the seeds should be washed and dried in the shade.

Planting and cultivation:—When about nine months old, the seedlings are planted out into the field, at a distance of seven feet each way. Transplanting is done at the commencement of the wet season, care being taken not to injure the root when transplanting. The size and depth of the holes depend very largely on the nature of the soil and the lie of the land. Temporary shade is afforded until the plants are well established. If the land is undulating or hilly, methods for the prevention of surface wash, such as catchment pits or terracing should be adopted. Manuring periodically is necessary; farmyard manure, when obtainable, is considered the best. Weeding should be carefully carried out and pruning is done in such a way as to keep the trees in shape, by thinning out superfluous or useless branches.

When in full bearing, a yield of about six to seven cwts. per acre is considered a good average crop, although under good conditions a larger crop may be obtained.

The above details show that Arabian coffee would therefore be suitable for cultivation in Malaya only at high elevations.



Raw Products for Alcohol Production.

Manufacture.

Raw Materials.

CHAPTER XII.

Raw Products for Alcohol Production.

ALCOHOL as a beverage has been known from the very earliest times and it is probable that the Chinese method of production from rice as practised in Malaya has been in operation since the remotest ages before the Christian era. It is recorded that, in India, arrack was distilled from toddy as far back as 800 B. C. With the growth of chemical knowledge and the expansion of modern industry, it has been found that alcohol has very important uses in many manufacturing processes; its use in the arts and crafts is increasing at a rapid rate and would increase more rapidly if the liquid were cheaper. The invention and perfection of the internal combustion engine have rendered possible the use of alcohol, alone or in admixture, as a liquid fuel, and if it could be produced and sold at a lower cost than petrol, there would arise a colossal demand. Practically the only obstacle to cheap production is a cheap and unlimited supply of raw materials, and since these are contained in almost every type of growing plant the future use of alcohol as a fuel and its production from various raw materials in tropical countries appear to be very promising.

The probability of the presence of suitable sources of raw material in this country renders it desirable to create an interest in the problem, and in this article the principal points involved in the manufacture of alcohol are briefly described and a short account of the natural products of Malaya which are under consideration as sources of raw material is given.

Processes of Manufacture. Ethyl alcohol, which is the chief constituent of all alcoholic beverages, is produced naturally by the fermentation of sugars. These sugars exist in nearly all plants and can be prepared also to a greater or less extent from starch or cellulose, which, as is well known, occur in large quantities in the vegetable kingdom. Thus, provided that suitably economic methods of production can be discovered, there is an inexhaustible supply of raw material from which alcohol may be obtained.

The usual industrial method for manufacturing alcohol depends upon the decomposition by ferments of starch in the presence of water. The starch is converted to sugars by one kind of ferment and these sugars are subsequently converted to alcohol and subsidiary bye-products by another kind of ferment. In the production of alcoholic beverages, the grain of such cereals as barley, rye, rice or maize is the source of the starch; the ferments employed occur naturally in the living plant or, in modern scientifically controlled distilleries, are cultivated as pure yeasts or moulds. A modification of the process for conversion of starch into sugar consists in the digestion of the original starch with a mineral acid (sulphuric or hydrochloric) and the subsequent fermentation of the sugars to alcohol. In the manufacture of rum, the raw material consists of sugars in the form of molasses (residue from sugar manufacture). In the normal fermentation of cereals or molasses to alcohol, the maximum alcoholic content of the fermented liquor is about twelve per cent, the balance consisting chiefly of water.

For industrial purposes and especially for use as power or fuel alcohol, the finished product must contain about ninety-five per cent of alcohol, and to obtain this, the fermented liquor, in modern factories, can be distilled in one operation by using a special type of still and rectifier known originally as a Coffey still.

Ethyl alcohol can be produced by other methods, the most important being synthetic processes of recent invention, such for example as its manufacture from calcium carbide

via acetylene. In addition, there are various methods for manufacturing methyl alcohol, a closely related chemical compound of great industrial importance which is also suitable as power or fuel alcohol. In this article attention is confined to the manufacture of ethyl alcohol, and the consideration of these raw products from which it can be produced on an industrial scale in Malaya.

Raw Materials. The materials for alcohol production may be conveniently grouped as follows :—

(a) Materials containing sugars only.

(b) Materials containing chiefly starch.

(c) Materials containing sugars, starch and cellulose.

(d) Materials containing cellulose only.

It will be convenient to consider those products which are common to this country under these headings.

(a) *Materials containing sugars only:*—These comprise saps of various plants, fruit juices and similar liquids. The raw materials which require particular mention are sugar molasses, nipah palm sap or "nera" and both coconut milk and toddy.

Molasses:—Sugar molasses, as a source of alcohol, although not of particular importance in Malaya at the present time, will become so if sugar cane cultivation is renewed. In Mauritius, where the production of molasses is approximately eleven million gallons per annum, the production of industrial alcohol from such a source becomes a matter of the greatest consequence. This applies also to several other countries in which the cultivation of cane sugar is of importance. A certain portion of the molasses in Mauritius is converted to spiritous liquors, such as rum, but the remainder —well over fifty per cent—is used simply as a manure. If the exhausted vinasse (that is, the molasses after having been fermented and distilled) were to be used as a fertiliser instead, it is estimated that it would be equally effective and the whole of the molasses would be available as a source of alcohol. Since molasses contains approximately thirty five per cent of sucrose or cane sugar and an additional fifteen per cent of invert sugar, every gallon of molasses will yield at least one pint of absolute alcohol, allowing for all process

losses, so that the possibilities of exploiting this source for the production of industrial alcohol can be easily seen.

Nipah palm:—The sap derived from the nipah palm (*Nipah fruticans*) merits earnest consideration as a possible source of industrial alcohol in Malaya and is already occupying the attention of the Department of Agriculture and also that of a number of planters.

"Nera" as it drips from the cut flower spike of the nipah palm contains on the average thirteen per cent of pure sucrose. In some instances the sucrose content is stated to be as high as eighteen per cent. The yields of juice from a number of nipah palms in the Kuala Selangor district, are being recorded; a single palm has been found to be very variable but there is evidence that the yield is generally higher than that obtained in the Philippines, and the total yield per annum from the palm known as "padi" nipah palm should be considerably higher than the recorded figures for Philippine nipah groves. According to Gibbs in the Philippines one plant will give fifty litres, i. e. twelve and a half gallons, of sap during the season and over an average area of wild nipah swamp the annual yield will be approximately ten thousand gallons of juice per acre. With an average sugar content of thirteen per cent and efficient factory procedure a minimum yield of half a gallon of absolute alcohol per ten gallons of juice is obtained, so that one acre of nipah palm can be safely estimated to yield five hundered gallons of absolute alcohol per annum. Gibbs has also shewn in 1911 that, by comparison of the prices of raw materials and the costs of production at that time, alcohol could be produced from Nipah sap at a lower figure than from any other material then known.

In this country probably the most important factor controlling the economic success of this industry will be labour supply.

Details relative to the collection, preservation, transport and subsequent factory treatment of "Nera" are being worked out in the laboratories of the Department of Agriculture, and it is hoped that before long a new industry may be established in Malaya.

Coconut palms:—There are several varieties of palms in this country which yield a saccharine juice by suitable methods of treatment. The most important is the coconut palm, the juice of which, obtained by tapping the inflorescence,

is known under the name of toddy. The fresh juice contains about sixteen per cent of sugar and it is stated that fifty gallons per palm per year may be obtained, yielding approximately two hundred gallons of absolute alcohol per acre per annum. The advisability of tapping coconut palms and allowing them to bear fruit at alternate and regulated periods has been urged by some who contend that the yield of nuts per palm and weight of copra per nut are considerably improved by intermittent tapping, but in the absence of records on this point, this statement is inconclusive, so that in view of the demand for copra, and the inherent difficulties of tapping at a height, the production of absolute alcohol on an industrial scale from the coconut palm is not considered practicable.

Another possible raw material from the coconut palm was thought to be the "milk" from the ripe coconuts, which is wasted in large quantities on the majority of coconut plantations. Investigations however, have shown that this "milk" contains only about one per cent of sugars and these chiefly non-fermentable, so that the utilisation of this material is not practicable.

(b) *Materials containing starch and sugar ;*—Under this heading are included grain of cereal crops and various tuberous roots.

Among the cereals, maize and rice can be cultivated successfully in this country. Maize at present constitutes fully seventy five per cent of the grain used for alcohol production in the United Kingdom.

The production of alcohol from rice is particularly interesting on account of the unique age and peculiarity of the fermentation process adopted by the Chinese. The "samsu" distillers in Malaya carry out the conversion of the boiled rice by means of a mould growth and although very inefficient in their hands it has been developed into a very efficient method and is now largely used in fermenting starch from other cereals in France and Belgium under the name of the Amylo Process. The importance of rice as a food stuff in Eastern countries precludes its use generally as a source of industrial alcohol. "Samsu," which is a beverage, is prepared from broken and damaged rice grains.

The production of alcohol from cereals in Malaya can therefore be considered as impracticable.

Among the starch yielding tubers which can be considered as raw materials in Malaya, the following are sufficiently easily grown to merit consideration as cheap sources of alcohol:—sweet potatoes, tapioca, or cassava, and Jerusalem artichokes. The relative cost of raw materials required to produce one gallon of pure alcohol are estimated to be as follows:—

	Cost of raw material per ton.	*Cost of raw material to produce 1 gallon alcohol.*
Sweet potatoes	$ 12/-	21 cts.
Cassava	8/-	13 „
Jerusalem artichoke	10/-	24 „
($1/-Straits Currancy		= 2/4)

Of these, cassava has been specially investigated with a view to its utilisation here. The tuberous roots contain chiefly starch and a small percentage of fermentable sugars. The average yield of root per acre under ordinary cultivation is ten tons. The content of starch in the fresh roots is about twenty five per cent, which can be readily converted to alcohol by fermentation as described above or by preliminary digestion with mineral acid and subsequent fermentation.

Sweet Potatoes yield approximately ten tons of tubers per acre containing approximately fifteen per cent of sugar and fifteen per cent of starch. By efficient methods thirty gallons of absolute alcohol can be produced per ton of tubers, so that the computed yield of alcohol from this crop is about three hundred gallons per acre per annum.

In the case of tapioca, a crop of stems amounting to a large weight of vegetable matter per acre is also produced. The stems have not been utilised up to the present except for re-planting, but if the roots were produced on a scale sufficiently large for alcohol manufacture, the stems could probably be put to some useful purpose, such as the production of pulp for paper-making, or by a modified process be also converted to alcohol. Experimental investigations on this problem are being conducted at the Department of Agriculture.

(c) *Materials containing sugars, starch and cellulose*:—Under this heading are included the grasses. Lalang, which is the most promising raw material in Malaya is under investigatian. The cut grass is submitted to an extraction process before it becomes dry, and a

saccharine liquid is obtained which can be fermented to alcohol In Kedah, the Malays produce sugar by cutting exposed roots of lalang and collecting the juice which exudes. By growing the lalang along ridges some roots can be exposed and cut daily without interfering with the health of the grass. In investigations now being conducted, the cut lalang, after extraction, is digested with soda and a cellulose pulp prepared as in the preliminary stages of paper manufacture, and this cellulose is saccharified by digestion according to one of the methods employed in the manufacture of alcohol from fibres or sugar beet residues, According to one method, the material is heated with very dilute sulphuric acid (0.5 per cent) using live steam at a pressure of 90 lbs. per square inch. The cellulose is converted to dextrose-sugar which can be afterwards fermented.

By another process the cellulose is dissolved in concentrated hydrochloric acid and the solution allowed to stand at the ordinary atmospheric temperature and then diluted.

Preliminary results obtained by applying these processes to lalang grass are sufficiently satisfactory to warrant continued investigation, and it would appear that if lalang can be cropped continuously with uniform characteristics, there is a probability of its utilisation as a suitable source for industrial alcohol.

(d) *Materials containing chiefly cellulose:* The materials which are included in this section differ from those in the preceding section since they do not contain saccharine matter which can be obtained from the fresh vegetable tissue by a preliminary extraction with water.

In other respects the treatment required for the production of alcohol is analogous to that just described. Under this heading wood and wood waste are the principal raw materials which can be converted to alcohol by suitable means, or which by destructive distillation can be decomposed with the production of wood spirit containing a proportion of methyl alcohol. The conversion of wood cellulose to alcohol by digestion with acids and subsequent fermentation has not, however, been fully worked out on an economic basis.

As far as this country is concerned, there is not sufficient timber worked to produce a sufficient quantity of wood waste, and it is highly improbable that the price of standing timber would permit of its utilisation as raw material for alcohol production compared with such cheap and easily obtainable raw materials as nipah palm, tapioca and lalang.

A raw material which may be also included in this section as a source from which alcohol might be prepared is the peat which occurs in quantities in various parts of the Peninsula. Investigations are in progress in the laboratories of the Department of Agriculture and exhibits in connection with the work are being shewn at the Malaya-Borneo Exhibition. Research on similar lines has also been carried out for some time past in England and the results are indicative of the success which may be achieved later here. A short summary of the possibilities of preparing alcohol and other products from this natural waste material is given under a separate article on Peat.

Summary and Conclusions. The following table shews the approximate yield of alcohol obtainable from various raw products which can be cultivated in Malaya, together with the yields from potatoes, which constitute an important crop in Germany for the production of industrial alcohol and also the cereals used at present in the production of alcohol for beverages:—

	Starch content per cent.	Sugar content per cent.	Tons per acre.	Imperial gallons of 95 per cent alcohol per ton of 2,240 lbs.
Sugar Molasses	—	53	—	65
Cassava (Tapioca)	25	—	6-15	39
Artichokes	17	—	—	22
Sweet Potatoes	22	5.5	4-10	35
Sorghum (Stalks)	—	14	8-20	12.5
„ (Grains)	66	1.5	0.54- 1.62	87
Potatoes	18	—	2- 6	20
Barley	59	—	0.33- 1.1	70
Maize	64	2	0. 5- 2.5	85

Theoretically, every nine tons of starch should produce ten tons of fermentable sugar, yielding about 5.1 tons of alcohol, the theoretical yield of alcohol, from starch being 56.8 per cent of the weight of the starch.

The theoretical yield is, however, never obtained in practice, but in an efficient plant, yields of over 90 per cent of the theoretical can be obtained.

The practical yield of alcohol may be regarded as 50 per cent of the weight of the available starch.

The theoretical yields of alcohol from cane sugar and glucose are 53·8 per cent and 51.1 per cent respectively of the weights of sugar.

In the above table the figures per acre show the variation between a good and a bad crop. The yield of alcohol per acre can be calculated from the figures given. Apart from the utilisation of alcohol for power purposes, the present consumption of methylated spirit, which contains from eighty three to eighty seven per cent of alcohol, is four million gallons per year in the United Kingdom alone.

Alcohol is in every way suitable as a liquid fuel and possesses certain advantages over petrol. The calorific value is only 11,000 B. T. U. compared with 18,500 B. T. U. for petrol, but owing to the greater degree of compression which can be used with alcohol in internal combustion engines, without danger of pre-ignition, a thermal efficiency of thirty per cent can be obtained in a properly designed alcohol engine compared with twenty per cent in a petrol engine. The most important desiderata in connection with the raw material for the production of alcohol are (a) a constant, abundant and accessible supply, (b) cost of production of raw material or price (c) starch or sugar content (d) unsuitability as a foodstuff. Thus, cereals such as rice, wheat, barley and maize may be ruled out generally, owing to their greater value as a foodstuff.

The following formula, which gives the price in pence per ton (P) which can be paid for the raw material is of interest:—

$P = Y [C - (P_1 + P_2 + P_3)]$

Y = Yield of 95 per cent alcohol in gallons per ton.

C = Retail price of alcohol in pence per gallon.

P_1 = Manufacturers costs and profits in pence per gallon.

P_2 = Cost of packing and distribution „ „

P_3 = Retailers expenses and profits „ „

Paper.

Raw Materials.

Source of Supply.

Manufacture.

Possibilities in Malaya.

CHAPTER XIII.

Paper.

THE paper industry of the world appears to be progressing towards a crisis on account of the serious shortage of raw material and its increasing inaccessibility. The forests of the northern temperate zones are being worked out and reafforestation is not keeping pace with the increasing demand. The belief has been expressed that no permanent solution to the present difficulties can be found except in the utilization of the vast stores of natural products of the forests and waste places of tropical and sub-tropical regions. The significance of this merits the consideration of all who are interested in the development and future industrial activities of Malaya on account of the scope afforded to any country able to supply raw material in increasing quantities to meet the colossal demands of the paper industry. The present consumption of paper is nearly twelve million tons per annum and according to recent computations this total is increasing regularly by 2.5 per cent annually.

Raw Materials. Ordinary paper consists of cellulose, a substance of vegetable origin, and various loading materials, chiefly of mineral origin. Cellulose is the essential

constituent, and it is on account of the inadequacy of the present commercial sources of this substance that the paper-making industry is searching for new sources of raw material.

The materials from which cellulose can be obtained are exceedingly numerous. An eminent scientist has stated that any vegetable substance in the world could be made into paper. Although this is scientifically correct, from a practical point of view the statement is fallacious, because, although paper is cellulose fundamentally and all vegetable matter contains cellulose, yet the difficulties and costs connected with the winning of the cellulose preclude the use of all but a very limited proportion of vegetable substances.

In reviewing the raw materials from which paper is being made on a commercial scale, the original vegetable matter may be regarded as consisting of a cellulose and a non-cellulose portion. The former however, is not a definite individual substance but must be considered as a family or group consisting of three members, which are conveniently described as fibrous cellulose, cellular cellulose and hemi-cellulose.

The non-cellulose constituents of plants are entirely worthless for paper making and must be removed completely. The value of the cellulose portion depends however on the proportion of the fibrous and cellular cellulose, for these are the true source of the fibre forming the intricate web of microscopic strands which, when rolled into a uniform sheet, is described as paper.

The seed hair of the well known cotton plant furnishes the best material. This is pure fibrous cellulose. It can be readily obtained in a pure condition and is the standard as regards its chemical and physical properties to which all other vegetable substances may be referred when expressing their potential value as paper making material.

In addition to the typical cotton cellulose, a valuable cellulose may be obtained from other flowering annuals. e.g. flax, hemp, China, Ramie or Rhea grass and other species, all of which contain fibrous-cellulose, but most of these are only obtainable by the paper maker as a waste product from textile industries.

The cellulose, which is used at present for the bulk of paper, it that described as cellular-cellulose, and is obtained

either from grasses or in the form of ligno-cellulose from wood or other lignified tissues.

From the point of view of the paper maker concerned with the discovery of fresh sources of naturally occurring raw materials, the second member—cellular-cellulose—offers the greatest possibilities. Wood is one of the enormous sources of supply which have been developed so largely by newspaper manufacturers. The best type of wood is the Canadian Spruce, but other wood can also be successfully utilised. In tropical countries there are many varieties of quick growing soft woods which should prove satisfactory, and in Malaya a common wood such as meranti can be pulped to produce a good quality fibre, while keruing, although not as soft, is quite suitable for pulping.

In this class of raw materials, the bamboo, although botanically a grass, deserves special mention. It was with special reference to bamboo that Sir Robert Carlyle made the statement as to a permanent solution to the paper shortage crisis. Bamboo grows with wonderful rapidity and it yields a high percentage of cellulose which can be converted into good quality paper.

There are many varieties of bamboo which flourish well in Malaya. These have not all been examined yet at the Department of Agriculture, but of those which have, and from previous work by Raitt in India, it is safe to say that bamboo may be regarded as a paper pulp source of enormous potential value.

Cellular-cellulose or ligno-cellulose can also be prepared from other grasses and straws. Among the materials of this type are corn stalks, waste vegetable fibre, sugar-cane vagasse, straw, flax straw, coconut fibre, esparto, lalang and a great variety of other grasses peculiar to certain countries.

Of these, certain varieties have been tried experimentally only, but others such as baib (*Ischaemum angustifolium)* have long been used and it is understood that for the past twenty five years baib has been the staple material of the Indian paper mills.

Paper Manufacture. The manufacture of paper may be divided into four stages

(*a*) Production of the raw bleached cellulose pulp.

(*b*) The beating of the pulp and its complete reduction to a mass of minute hair-fibres forming an intimate mixture with water.

(*c*) The incorporation into this mixture of the requisite loading materials and the sizing materials.

(*d*) The passing of the thick liquor prepared as above over the paper making machine whereby the water is strained out, the fibres and other materials are deposited in a coherent web-like structure and the subsequent pressing and rolling of this material to eliminate the water and to produce a compressed, even, smooth-surfaced sheet of paper.

Operation A.—For the production of *chemical pulp* the raw vegetable material, for example grass, or the residual cellulose from some other industry, as in the case of rags, is digested with a solution of caustic soda for a period which may amount to six hours. The material is treated with live steam in rotary or stationary boilers at a pressure of ten to twenty lbs. per square inch, or considerably more in some instances. At the expiration of the prescribed period — the optimum conditions having been determined by previous investigation — the caustic liquor is run off and the pulp is transferred to another plant in which it is thoroughly washed. After washing, bleaching is carried out by the use of bleaching powder solution, or in some cases by the direct use of chlorine gas. At the same time, a certain amount of beating takes place in order to assist the bleaching agent in its work and to facilitate operations at a later stage. In the production of pulp from the cellulose in wood, the alkaline digestion process in not adopted generally.

The wood is disintegrated by chipping or crushing and ground to such a fine state of division that it will form a pulp with water. The pulp so formed is known as mechanical pulp and is used in enormous quantities for the production of cheaper kinds of printing paper and for cardboard etc.

A process of digestion with an alkaline sulphite solution is also largely used for the manufacture of pulp from wood. This is a chemical process and depends upon the same principles as the previously mentioned caustic soda digestion method used for the raw material.

Operation B:—Subsequent to bleaching, the clean, partially beaten pulp is transferred for further beating to a machine known as a Hollander. This may be compared to an elliptical dish in which is arranged a paddle-wheel with many very short-bladed paddles. The revolution at a high speed of this wheel, half submerged in the contents of the dish, causes the liquor to circulate and at the same time beats and frays out the fibres in the lumps of cellulose material resulting from the boiling treatment. In addition to the mechanical effects of the beating, the cellulose, by virtue of the action, also combines chemically with a definite proportion of the water in which it is floating, and thus the paper maker produces the different characteristics of wet-beaten or "hydrated" pulp and a "free" pulp.

At this stage the pulp is known technically as "stuff" and it is at this stage that the loading materials are added, also the sizing materials, if the object is to produce an engine-sized paper.

Operation C:—In actual practice there is no line of demarcation between operations B. and C. The object of the paper maker is to incorporate as completely as possible all the materials which form paper, namely water, cellulose, loading and size. This can only be done by adequate and careful beating and the benefit of the additions of china-clay, rosin, size etc. would be entirely nullified if they were not thoroughly beaten into the cellulose-water emulsion.

Operation D:—When the "stuff" is completely beaten it is ready to be run over the paper making machine. This is a complicated piece of machinery which receives the "stuff" at one end and turns out a finished roll of dry paper at the other end. It is beyond the scope of this article to attempt to furnish a satisfactory explanation of its operation. Moreover the manufacture of different varieties of paper calls for different modifications and types of machine.

The intention is rather to point out that operation D. in the manufacture of any kind of paper, is one that calls for highly skilled control and labour, also expensive and complicated machinery, whereas the previous operations, for the production of "half-stuff" and "stuff" are such that, with skilled control, the plant is comparatively inexpensive and could be run quite successfully in a country such as Malaya.

Possibilities in Malaya. Having outlined briefly the salient points necessary for an understanding of the art of

paper making it is desirable to consider the commercial and economic possibilities of the industry in this country.

From the description already given it can be seen that certain plants specially suitable for yielding cellular cellulose are indigenous to Malaya. Others, if not indigenous, flourish so well that they are regarded as weeds. The chief question to be considered therefore is whether these plants can be transformed profitably into raw material suitable for shipment.

Profitable transformation into partially beaten pulp or "half-stuff," which could be shipped in a compressed form, would involve the following steps :

1. Harvesting.
2. Transport of crop to factory.
3. Factory treatment.
4. Transport of product from factory.
5. Regeneration of plants.

The harvesting will be dependent on the type of crop which is being grown. Each raw material may be considered briefly.

Wood :—Forest trees will require to be selected, suitable wood being picked out from amongst the huge volume of forest growth which occurs together naturally, but which the pulp manufacturer could not treat successfully in a mixed condition. The difficulties of selective cutting and transport of the selected wood will probably preclude the use of forest trees, unless large tracts containing trees of one species could be worked. These sometimes occur naturally or can be developed by afforestation. The enormous area which is now under soft wooded rubber trees in this country indicates the possibilities in this direction. Experimental work already carried out at the Department of Agriculture has shown the possibilities of devolopment on these lines.

Bamboos :—The common bamboos in Malaya grow in many instances in large areas where there is not a profusion of other heavy vegetation, consequently harvesting should not be difficult. Culms are thrown out continuously over a long period, and cropping may proceed without intermission

until the bamboo flowers, when the clump dies off. To provide against this it would be necessary to have available the requisite supplies of bamboo of another variety. The localities where bamboo flourishes naturally are somewhat inaccessible and the question of transport of the cut culms requires serious consideration.

Grasses :—Another source of supply for pulp manufacture, which requires particular consideration in respect of harvesting, is lalang grass. Definite data as to cropping in Malaya have not yet been obtained, though it is understood that in the Philippines some valuable work has been carried out. If vaste waste areas, artificially sown, could be relied upon to frunish this grass, without alteration in its characteristics, over a period of ten to fifteen years, then lalang would be a certain source of wealth to this country, since its value as a paper making materials has been established.

Factory treatment :—Factory treatment of the three types ot material discussed above necessitates adequate supplies of power and water. Fuel is limited in amount in Malaya and it would therefore be desirable as far as possible to utilise water power. According to some authorities this would appear to be possible in the majority of districts where bamboo occurs, but whether the same is true for wood or grass requires to be investigated.

The steam for digestion of the raw material would necessitate the use of fuel, which in most localities could only be derived from local jungle and, since the areas immediately adjacent to the factory would be taken up with the growth of pulping material, the fuel could only be obtained from distances which would make transport an important item. The question of the digestion itself calls for no special comment except in the case of bamboo. Raitt has shown that, in order to produce a white pulp from bamboo, it is necessary to adopt fractional digestion. The process has now been completely worked out and presents no difficulties.

The production of " half-stuff " and fully worked pulp requires a very large volume of water, estimated at about thirty thousand gallons per ton of pulp made from grass, and increasing to as much as fifty thousand gallons for particular varieties of raw material. The quality of the water must also be carefully examined, suspended matter and " soluble iron " being particularly deleterious.

In addition, the provision of an adequate supply of lime near the pulp factory is an enormous advantage, for by the use of quick lime, the caustic soda used up in the digestors can be efficiently and economically recovered; the recovery process depending solely on suitable plant for evaporation and filtration.

For the transport of finished pulp from the factory the only economical means would be by river, and it is probable that a form of compressed pulp, such as that exhibited by the Department of Agriculture, would be the most suitable. The pressed blocks can be prepared easily and cheaply, they require no packing, and subsequent disintegration is very simple.

Conclusions. Having in mind the various points discussed in the course of this article, it can be seen that prospective pioneers of pulp manufacture in Malaya are faced with many serious problems, and it is necessary to insits upon the difficulties likely to be encountered, for undue optimism would undoubtedly do more harm than good; there is however reason to believe that Malaya night become a large pulp producer, provided the raw materials are present in sufficiently large area in a particular district.

Experimental work is still in progress on the most likely sources of raw material and the Department of Agriculture is conducting investigation in collaboration with the Forestry Department on matters particularly vital to a possible future industry in this country. Exhibits in connection with this work are being shown at the Malaya-Borneo Exhibition as already mentioned.

It is not desirable or opportune here to give a detailed account of the points under investigation. Neither is it yet possible to state the most suitable material for treatment and the profits awaiting those who turn their attention in the direction of paper pulp manufacture, but it is considered that there is a future for the paper pulp industry in Malaya, and if the above will awaken sufficient public interest to promote further enquiry, the object of this article will have been achieved.

Peat.

CHAPTER XIV.

Peat.

IN order to appreciate the importance of the problem of utilising peat deposits it is only necessary to realise the extent of the surface of the globe which is covered by peat bogs. In Europe alone this area amounts to 212,700 square miles.

In Malaya it is not possible to state exactly the area of peat but it represents a fair proportion of the total area and the necessity for considering the problem here is probably as important as it is elsewhere.

Peat should not be regarded merely as a waste material, and the areas covered by it as useless. It consists of decomposing vegetable matter saturated with water, and contains valuable compounds such as cellulose, organic nitrogenous bodies, complex hydrocarbons and mineral salts which by suitable treatment can be transformed economically into other substances of industrial importance.

Investigations in connection with the problem have been carried out by various scientists in the past and there is

much information available on the possible uses for peat and its products. It is considered desirable to call attention to the possibilities, e.g. alcohol, paper, peat as a fuel, ammonia, and acetic acid.

Alcohol from Peat:—In 1907 it was stated by a special committee of the Motor Union appointed to consider the advisability of substituting another fuel for petrol "that "alcohol offered the most complete and satisfactory substitute "for petrol, and alcohol production would form a home "industry if peat were utilised as the raw material."

As a result of the findings of that committee the subject of the production of alcohol from peat received renewed attention. The wet peat, when mixed with acidified water and boiled under a low steam pressure, yields saccharine substances, which after neutralisation with lime can be fermented to alcohol by the use of a special yeast. It is recorded that in his original investigations Sir William Ramsay extracted six gallons of alcohol from one ton of wet peat.

Subsequent investigations indicated that one of the most important points is to arrest the acid digestion of the peat at the right stage, otherwise the sugars at first formed are attacked and destroyed, and the further formation of sugars produced by the decomposition of the cellulose in the peat does not compensate for the loss of the original sugars.

A firm in Copenhagen has developed and is working a process on a large scale for the extraction of alcohol from peat, and it is stated that about forty gallons of absolute alcohol, together with sixty six lbs. of sulphate of ammonia and other valuable bye-products are obtained per ton of dry material. It is claimed that the cost of the alcohol is only 4¾d. per gallon.

In this country the subject has only recently received attention from the Department of Agriculture, but, as far as the work has progressed, it has been shown that the peat obtained can be treated in a manner very similar to that used in the original process referred to above.

After the peat has been treated for alcohol production, a bulky residue remains, which after drying, forms a very suitable fuel, and which also contains valuable nitrogen compounds.

Peat as a source of paper:—The cellulose from the residues from the alcohol process or from fresh dry peat, can be beaten to a pulp capable of being converted to a fair quality, blotting paper, a rough brown packing paper or cardboard.

There appears to be no suitable economic process for completely bleaching the peat fibres for the production of pure white paper, but in view of the large demand for packing wrappings, a light brown or yellow colour is not a grave objection.

In one of the most successful processes for the manufacture of cardboard the peat is saturated with water containing a small proportion of bromine which attacks the gummy substances surrounding the fibres and renders them more soluble in an alkaline solution. The mass is thoroughly agitated and soda ash is subsequently added; the mixture is then heated for about five hours under steam pressure. After the digestion, the alkaline lye can be drained away and the resulting fibrous mass washed thoroughly with water. It desired, this can be partially bleached by the usual treatment, with chlorine water or bleaching powder solution. The fibres are then beaten in an ordinary Hollander and when the half-stuff is ready it may be run to the paper-making machines alone or may be incorporated with half-stuff from other sources for the manufacture of almost any type of paper.

Excellent blotting paper is made from this material and is said to be particularly absorbent and satisfactory, owing to the hydrated state of the cellulose in the original peat.

Peat as a fuel:—In this country the production from peat of an efficient fuel appears to be a matter of importance. The industrial development of a country depends largely on its fuel supply and peat exercises its most important function in industry as a source of fuel.

If the peat deposits of Malaya can be utilised as supplies of fuel a great step will have been achieved in the industrial progress of the country.

In order to appreciate fully the possibilities of peat fuel it must be remembered that the solid matter of peat consists very largely of carbonaceous matter, and that under suitable conditions of burning this will behave like a soft coal, and yield distillation products which are inflammable and have a

high calorific value. Apart from the conversion of peat to briquettes, for burning in an open hearth or under forced draught, there is the possibility of destructive distillation of the carbonaceous matter in order to obtain tarry distillates and a gaseous product that can be either stored and afterwards burnt as required in the same manner as coal gas at home, or which can be utilised directly in gas engines as a source of power.

During the production of this gas from a still or from a gas producer, the peat yields also a large proportion of liquid distillate which is a mixture of many valuable materials; acetic acid, ammonia and tar occur in the greatest quantities and with the production of these only (and not as bye-products) it has been considered possible to make a reasonable margin of profit.

Investigations which have been conducted at the Department of Agriculture have shown that the peat deposits in the west of Selangor are eminently suitable for distillation. It has been found that one hundred pounds of air-dried peat yield on the average three hundred cubic feet of gas. This has a good calorific value and can be used to replace coal gas or oil gas produced by cracking kerosene oil. The peat also contained over 1.5 per cent of nitrogen, and this under suitable conditions could be transformed into ammonium sulphate.

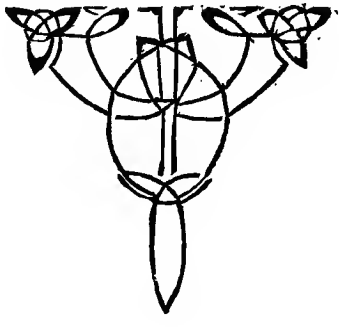
The combusion of peat in an ordinary charcoal producer has also produced instructive results. It was found that a National gas engine could be successfully run on peat gas and the consumption was only four hundred lbs. of fuel per hour.

The water content of the peat is an important factor in the composition of the gas which is evolved during combustion in a producer. When peat is excavated it contains usually between seventy per cent and eighty per cent of water and a proportion of this must be removed before the mass will burn. Drying can be effected quite satisfactorily in this climate by allowing the peat to remain exposed to the air for a fortnight, during which period the water content will have been reduced to forty per cent or fifty per cent and the mass becomes suitable for charging directly to the producer. In some cases it may be necessary to start operations by a charge of very dry peat containing only ten per cent of moisture, but the greater the proportion of water which can be decomposed with the carbonaceous matter the

more efficient the process becomes. Gases such as Mond gas, blue gas, water gas and others of that type are manufactured by introducing live steam into the bottom of the producer, and in the present instance it has been found that if the producer can be made sufficiently hot, it is possible to decompose peat containing sixty per cent of moisture. The gas consists of a mixture of hydrogen, carbon monoxide, methane, and carbon dioxide, and has a calorific value of approximately 135 B. T. U. per cubic foot.

Naturally there is a greater proportion of liquid bye-products obtained during the combustion of this fuel than there is when charcoal is consumed, This necessitates the use of a somewhat larger scrubbing plant. The ordinary type of scrubber can be altered without much expense, and the value of the scrubber liquids, which are obtained will, very rapidly pay for the cost of the alterations effected.

In conclusion, it is desirable to point out that the utilisation of peat has attained considerable dimensions in other countries and that much of the work has long ago passed beyond the experimental stage. While undue optimism in Malaya is to be deprecated, failures which have occurred in the utilisation of peat in Ireland should not be considered too seriously. Messrs. Crossley of Manchester have erected and worked large plants for the gasification of peat, and in one particular instance, the installation is used for the production of power for a central electric distributing station. It is accepted that, with gas engines running at seventy per cent of their full load, one ton of dry peat will produce 1,000 B. H. P. and by a rough approximation it can be seen that an acre of wet peat can be made capable of producing one and a half million units of electricity.



Cattle.

CHAPTER XV.

Cattle.

MALAYA possesses no distinct breed of domesticated cattle indigenous to the country, the stock found being of Indian or Siamese breeds, or crosses between the two. Some of the latter are excellent animals, but the majority of them are poor specimens. This is due largely to their being inbred, and to their having been starved as calves.

The system of breeding is at fault. The cattle are in small herds, as a rule, and, as the males are not castrated until they are at least two years old, a large amount of inbreeding takes place, with the result that the stock becomes more and more degenerate.

Indian Cattle:—Large numbers of bulls and bullocks are imported every year for draft purposes, and consist mostly of good specimens of the various breeds found in South India. They are large animals, mostly grey or white in colour and are very useful for draft work. The climate of Malaya appears to suit them, as with reasonable care they continue to do useful work for a number of years. Some of the breeds,

on account of their hard feet and quick gait, are especially useful for road work, while others are better suited for estate work. These cattle are very little used for cultivation work on estates, the smaller Siamese breed being more popular for this class of work.

A number of cows and heifers of Multan, Ongole, Hansi and other breeds of milch cattle, are imported annually, and are bought by Indians usually at high prices. The price varies with the yield of milk.

Siamese Cattle :—A large number of Siamese cattle are imported annually for draft purposes, and many more for butcher purposes. These cattle are small compact animals mostly red in colour, and very useful for all kinds of draft work. They are excellent for road work and for cultivation work on estates.

A number of cows and heifers are imported from time to time, but they are poor milkers and are not greatly in demand.

European Cattle :—A number of cattle of European breeds—chiefly Shorthorns—has been imported at various times, but the climate does not suit them. They require special attention as regards feeding, protection from disease, and protection from the sun. As a rule the cows do not keep up their reputation as milkers, and bulls become less fecund. As an up-grading factor, they are an undoubted success. Crossbred calves show a distinct improvement in every respect. The male calves become bigger and more powerful animals than either of the parents, and are excellent as draft animals and as beef producers. The heifers become much better dairy animals than the pure Asiatic cows. If these cross-bred animals were used regularly for stud purposes, the class of cattle raised in the country would very soon show a distinct improvement.

Buffalo :—Throughout the country, there is a large number of water buffalo or "kerbau." They are too slow to be useful for road work, but for the cultivation of padi land, for which purpose they are largely used, they are excellent, and could not be replaced by any other animal. They are also used largely by Chinese to drag heavy timber from the jungle, and for this work they could scarcely be bettered.

There are two distinct breeds in the country, differing in size and shape. One is a large-boned, heavy, gaunt animal,

capable of pulling a heavy load, while the other is a much smaller but compact animal of a beef type.

The cows give a small amount of milk, rich in butter fat, but they are used for breeding purposes only and not as dairy animals.

In the neighbourhood of practically every town are to be found a number of Delhi buffalo. These are large in size, with deep wide frames and short thick legs. The horns are very characteristic, being thick at the base and incline backwards and upwards and then curl up in two or three coils. They are kept by Indians, purely for dairy purposes, and supply a large proportion of the fresh milk sold to natives.

Beef:—Siamese cattle provide the greater proportion of the fresh meat in the markets. These cattle, with their compact frames and small bones, kill well, and provide a large quantity of meat of excellent quality. The meat produced by Indian cattle is not so succulent as a rule, being provided by animals which usually have been at work for some time. Buffalo meat, which is a regular article in the market, is dark in colour and scarcely as palatable as Siamese meat.

Milk:—For the most part, milk production is in the hands of Indians. Many of these have herds of excellent Indian cows, which they look after well. Unfortunately, little attention is paid to proper breeding, with the result that no improvement in the yield of milk per animal is obtained. The lack of suitable grazing ground in the neighbourhood of towns interferes seriously with extensive dairying.

Indian cows in this country, on an average, give eight to ten lbs. of milk per day, with occasional cows giving up to twenty five lbs. per day in the early part of their lactation period. The milk is rich in butter fat, the average being about five per cent.

Delhi buffalos give a considerably higher yield of milk than do Indian cows. On an average the daily yield of milk is about fifteen lbs., with a butter fat content of six to eight per cent.

The extent of adulteration of milk in this country is considerable. Water is generally used, but lime water and occasionally flour, are used to improve the appearance of diluted milk.

Feeding :—No attention has been paid up to date to the laying down of good pastures, or to the growing of suitable fodder crops for cattle food. A number of varieties of good forage grasses are to be found growing wild in various parts of the country, and a few private individuals grow small patches of Guinea grass and similar fodder crops. The introduction of new fodder crops is desirable.

There are many "kerbau" grazing grounds throughout the country, but the grass is largely lalang, and a few poor natural grasses, On such pastures, buffalo thrive reasonably well, but cattle, and especially dairy stock, do not thrive well.

Draft bullocks are usually given a supply of grass cut from the road sides and from waste land, but to keep them in good working condition, the owners have to feed them liberally with concentrated food. If this is not done, the cattle are miserable in appearance and are more subject to disease.

The buffalos used by the Malays for padi cultivation find sufficient nutriment in the coarse grasses in their pastures, and in the soft water grasses which grow in the rice fields.

Generally speaking, no attention is given to calves. They are allowed to draw a small amount of milk from their mothers, and are expected to thrive on the coarse grasses they find. The result is that they are always lean and stunted in growth, and take a long time to reach maturity.

Requirements of Malaya:—Cattle in Malaya require to be improved, and the first step to be taken is the improvement of pasture grasses and fodder crops. While cattle are half starved, they cannot be improved.

Legislation, compelling the castration while young of undesirable calves, is urgently required. This would help to put an end to promiscuous breeding.

A considerable number of good bulls must be obtained, and used to cross with the cows in the country.

Unfortunately, owing to the financial situation, a proposal put forward by the Department of Agriculture for a Stock Farm, has had to be postponed, but it is hoped that it will be possible to start such a scheme, as soon as circumstances permit.

Poultry.

CHAPTER XVI.

Poultry.

THE breeding of poultry from the utility point of view has, during recent years, made great progress. Contrary to the former popular notion, poultry assist the householder since they destroy many of the pests of the garden, and by eating up all kitchen scrap, deter the visits of rats.

Poultry keeping is not advocated here as a sole business proposition, but as a side-line, and as such it would appear that there is a future for the industry.

This country has its own variety of fowl, which was exhibited early in the nineteenth century at Shows in England. Over forty Malayan birds were exhibited at the Crystal Palace Poultry Show in 1921.

The Malayan Fowl:—The Malayan fowl has a walnut-like close fitting comb, broad head with beetle brow, long straight limbs, wide shoulders, sloping back with the tail carried rather low, giving three distinct curves—neck, back and tail.

The feathers are free from lacing and spangling, and are narrow and short, causing the bird to look smaller than many of our English varieties, with which they compare quite favourably however when placed on the scale.

Housing. The house must be dry and free from draught, though fresh air and light are required. It is well to have the upper part of one side, preferably the south, wired. Coconut ketta and attaps are not suitable for side walls on account of snakes and civet cats, but there is in the country a large variety of easily obtainable and suitable material with which to construct the house. Nibong slats placed about one half inch apart have been found very satisfactory. The house should be made fairly large to allow for increase of stock.

Three to four square feet of ground space per bird are required ; thus a house six feet long, five feet wide, and about five feet high would be suitable for ten adult birds, but it would be wise to increase the height slightly if external nest boxes are not fitted. The floor level should be raised about six inches above ordinary soil level to avoid damp, This may be done by the use of soil or cement.

The perches, constructed of about three-inch diameter poles without bark, should be about two to two and a half feet from the ground and on one level. About six inches below each perch there should be a board or piece of old sheet iron covered with soil or lime, to catch the droppings. These boards should be cleaned regularly and the manure used in the garden. If this system of dropping boards is adopted, the main floor should remain clean and therefore might with advantage be covered with old leaves, dry peat, cut grass or other suitable material, to a depth of six to eight inches. The evening grain scattered into this litter provides healthy recreation for the birds. The litter only requires renewal every three or four months. Where snakes are troublesome, perches in tiers, the highest about five feet off the ground, are advisable.

It should be remembered that a busy hen pays best, the early riser and late rooster generally contributing well to the egg basket.

In large farms automatic feeders are installed so that the bird by picking at a bar knocks a few grains to the ground ; in this manner it obtains exercise and stealing of grain by other birds is prevented.

There should be a bird entrance to the house, which can be closed at night by a sliding board to keep out vermin. It is almost needless to mention that there should be locks on the main door and external nest boxes, to prevent theft.

Internal nest boxes may be constructed in the form of shelves, the lowest shelf being about two feet from the floor with the nest shelf one foot above. Separate nesting boxes are made by dividing the spaces between the shelves with wooden partitions one foot apart and with a three inch deep strip along the front to keep the grass or other nesting material in position.

Hens should be provided with a dry bath consisting of a box of fine dry soil or soil and wood ash which they can shake through their feathers in order to kill any insect pests. If this is not provided the birds generally find a substitute in a flower bed or other convenient place, to the detriment of the garden.

When a court or run is provided it is advisable to place the house in such a position that the court may be changed from side to side every six months and that lately occupied used for vegetable growing. This is easily done by using wire six feet high with two inch mesh or fruit netting on light posts with a wooden frame door at one end. If the birds tend to fly, all the flight feathers on one wing only should be cut; when the birds find their balance uneven, they will prefer the ground.

It is stated that poultry do not pay unless they have free range. It is true they find the major portion of their own food when loose, but many poultry keepers keep their birds always in-doors, providing about three square feet per bird deep scratching litter, and placing mash and water on different tables, so that the birds have to jump about for exercise. Birds housed on a flat roof in a city by the intensive system during the war produced good profits.

Selection of Stock :—Selection of stock must be considered according to whether eggs or table birds are desired. For egg production the lighter breeds such as Leghorn and Ancona, weighing four to five pounds, are best, but for good table birds Sussex, Orpington and other heavy breeds weighing seven to eleven pounds are desirable. During recent years some strains of heavies have been improved for egg production with the tendency to reduce the size of the bird. The production of over 300 eggs per bird in its first season is not unusual in England, Australia and America.

It is clear therefore, that work is required to keep up the system. Such birds have forgotten to become broody since incubators have been used on the farms on which their ancestors lived.

There are few records at present concerning egg laying in the Federated Malay States but last year records from ten birds gave an average of one hundred and eighty eggs per bird.

Birds for egg production should have the following characters; a bright prominent eye, an alert active expression and carriage, body, broad across the back and somewhat wedge-shaped with the tail carried high at the wide end of the wedge, as viewed from the side, and placed on wide-set legs which are not too long; in other words, foraging power and egg capacity should be considered.

Hoogans test:—If a good egg producer is handled it will be found that there is space for three or four fingers placed across the body under the little bones (Pelvic) below the tail and above the end of the breast bone (Sternum). In a hen these little bones should also be straight and fairly thin, finishing wide apart.

In a male bird of good type, the former characteristic should hold good except that the pelvic bones almost meet.

An important point to remember in poultry breeding is that the character of egg production is transmitted more strongly by the male than by the female. Much may be done to improve the native bird at little cost by destroying all native cocks or cockerels (males under a year) and introducing birds of the desired character. The native cock, being of the game type, will destroy most of the other varieties of cockerels or keep them so actively on the run that they are useless.

Birds of about seven months old are suitable to start with since they will have about a month to settle in their new quarters before they commence laying. One male should be able to run with from twelve females in heavy varieties to twenty females in the light varieties. Where a large flock runs loose, one or more than two cockerels should be kept, since two may pick a quarrel and maintain it for days.

If eggs are not required for hatching purpose no male bird is necessary. Infertile eggs are, in fact, an advantage owing to their superior preserving qualities.

Feedings. There is a difference of opinion as regards feeding poultry. Some are strong advocates of dry mash, others of wet. If dry mash is used, the hoppers may be filled with a week's supply at a time and opened at feeding times, but the birds must not be allowed to scratch and pick what they want. The dry mash saves labour and causes the birds to take exercise as they cannot swallow all their food without running several times to the water supply.

A well balanced ration consists of one part of protiens to six parts of carbohydrates,

The following gives an idea of the constituents of poultry mixture used in the British Isles :—

By measure :—

8	parts	Bran
10	„	Middlings
3	„	Sussex Ground Oats
4	„	Maize or Pea meal
4	„	Meat or Fish meal

If this mixture is used wet, maize or pea meal should be omitted and biscuit meal substituted as the mash can be made into a more crumbly state and therefore a more suitable condition for the hens.

In Malaya a mixture of forty parts of rice bran, ten parts of coconut punac, two parts fish meal (made from small dried fish sold in the Chinese shops) gives fair results, though it is difficult to make it sufficiently crumbly. It contains proably more fibre than a strictly balanced ration should. Salt in small quantities dissolved in the water of the mash is quite good, but free salt is often fatal to poultry.

Green Food :—Green food is necessary, especially when the birds are confined. This can be supplied from lawn clippings, garden weeds, bruised fruit and similar substances.

Grit :—Birds, having no teeth, must be provided with a regular supply of grit or small stones which passing into the muscular gizzard, aid largely the digestion. Crushed shells are suitable or even finely broken porcelain may be used. It is advisable to mix about one per cent of crushed wood charcoal with the grit.

Birds kept in runs or courts should be given two and a half ozs of mash per bird at about 6 o'clock in the moring, green food and house scraps at about 1 p.m., and about two a and half ozs. of grain (padi or wheat) per bird at about 6 o'clock in the evening. Since the daylight in the tropics is rather short for full activity of a hen, this may be remedied by placing artificial light in the poultry house and giving the birds some grain to scratch out of the litter. A petrol light lit at dusk and turned out at 9. p. m. (in November in England) is said to raise the output of eggs twenty per cent. A disadvantage of the system is that there is difficulty in getting the birds back to roost, but this may be overcome by gradually lowering the lamp for the first few days. The pullet chick is endowed with the capability of laying thousands of eggs and the poultry farmer should try to obtain as many of them as possible.

An article published in a recent American Journal on dissection of birds advocated the extension of life of birds on poultry farms, since it is impossible to obtain half the number of eggs the birds are capable of laying in the usual two laying seasons. Records were given of five year old birds showing a profit, but generally poultry are not allowed to run much beyond the second laying year, i. e., about three years.

Diseases. Internal worms utilise the nourishment of their host and should be destroyed as quickly as possible. Chicks should be treated for worms when about one month old; if this is not done in the tropics, many will die before reaching the age of six months. The serious effect of intestinal worms in retarding the growth of the bird and in reducing the production of eggs cannot be over emphasised.

The birds should not be fed in the evening before treatment, in order to keep the intestines empty and give the drugs a better chance. A pill containing one grain of santonine and five grains of arecanut given to adult birds (¼ to ½ dose for chicks) in the morning, followed by a very hot meal at 4 p.m. such as bread soaked in boiling water, is very effective. Five drops of chenopodium oil in a teaspoonful of castor oil is a useful alternative medicine.

The birds should be confined for twenty four hours on cement or board floors sprinkled with lime so that all the worms expelled may be easily removed.

A large pinch of Epsom salts is an effective drug for many ills, and should be given if the bird begins to be lazy and has loose feathers. If the bird is not feeding well an addition of chopped onions tends to make the food more appetising. It should be remembered that weaklings are not worth troubling about in utility work.

Hatching. The eggs for hatching should be from healthy birds. They should be of even size and texture, showing no deformity in shell and must be stored in a cool place. For incubator work the eggs should be less than a week old, but for hatching under broody hens, eggs twice that age are suitable, especially if they have been turned regularly. There are several types of incubators on the market (Samlin, Hearson, Phipps etc.) which are quite simple and successful. Since birds in the East, with few exceptions, want to sit, the procedure for dealing with broody or sitting hens is described. It is not fair to expect a bird to be successful when sitting in the ordinary house unprotected. All laying hens want the broody hen to hatch their chicks with the result that she has more eggs that she can cover, and this is fatal. To prevent this a small box about fifteen to eighteen inches square should be obtained and a strip of wood threes inches wide placed along each edge of the top. A board is fitted between these leaving a space of about three-quarters of an inch." Two cross strips are nailed to each end—the nails going only into the strips. The lid board can be slipped backwards or forwards. The box should be placed on its side on a shelf away from damp, and the floor covered with cut grass or shavings. The broody hen should be placed with an egg inside the box, she will then settle down. She should be removed for feeding twice daily for ten to fifteen minutes and given plenty of grain and fresh water. Several broody hens may feed together, but after feeding each must be returned to her own box.

A day or two after the hen has settled, she should be given as many eggs as she can cover, but it is advisable to be one short rather than one too many as, in the latter case, the eggs run the chance of being chilled in turn in which case they will not hatch. There has been much discussion concerning the sex of eggs. On poultry farms where pullets are required, double the number of eggs are hatched to obtain a required number of pullets.

After eggs have been under the hen or in the incubator for ten days they should be examined in front of an ordinary

round the egg with the wide or round end uppermost. If the egg is going to hatch the air chamber at the top will be quite clear and the remainder of the egg dark, but if the body of the egg is quite clear it should be removed. The egg may be boiled, fed to chickens or even used for cooking purposes. The egg is infertile, if when broken a clean yolk with the two white chalaza at each end are observed. If the yolk is discoloured the chick has started to develop and has been chilled.

When the chicks appear, the egg shells should be removed from the nest morning and night. There is no immediate necessity to feed the chicks as they can easily maintain themselves for forty-eight hours on the legacy left them in the yolk; if fact, they are preferbaly left, until all the yolk is absorbed. Newly hatched chicks may be transported from one end of the British Isles to the other. With reasonable care young chicks can equally well be transported considerable distances in the Tropics. As native hens in this country tend to roam, the hen with chicks should be confined in a coop with a barred front for the first week, so that the chicks can run out at will. The coop must be kept dry and closed at night with boards or a wire front to prevent rats from eating the chickens.

If an incubator is used the chicks may be given to a broody hen in the evining when the hen will adopt the family. Capons also have this instinct and are so used on some farms.

Chickens should be kept off damp grass in the early morning.

Feeding of chicks:—A supply of grit is required for chickens. Dried egg shells may be crushed up and given them at first. After a bird is one week old sea shells should always be given but never egg shells. Round ground oatmeal, biscuit crumbs, and stalbe read toasted and crushed make good food. Food should be given in small quantities as it should always be picked up at once. When the chickens are about one week old, crushed wheat and crushed maize may be substituted to reduce costs.

The oatmeal may be stopped altogether after three weeks, but if the chicks are only getting padi, a hard boiled finely chopped egg every second or third morning, or a few white ants, should be supplied.

Kambu, (Grey millet) obtained in native shops, makes very good chicken food. Fresh water is necessary and this should be kept as clean and cool as possible. A good fountain may be made by filling a jar with water and placing an old saucer on the top, projecting about an inch around the jar. A match is placed across the edge of the jar and the whole inverted

Treatment for worms should be commenced after a month by giving a dose of two drops of chenopodium oil in half a teaspoonful of castor oil, after fasting, as in the case of adult birds. The monthly dose of chenopodium should be increased by one drop until an adult dose is reached.

If there are no bushes near the coop, shelter should be provided by laying here and there small boxes with one side removed so that the chicks can take shelter when the older birds raise an alarm that hawks are in the vicinity. The hen should be taken from her chicks when the latter are about one month old, otherwise the coop becomes over heated at night and the birds suffer from colds. Chicks should not be allowed to perch with the adults till they are about six months old, as perching often twists the soft breast bone.

As soon as cockerels can be distinguished from pullets they should be separated. When they have developed their frame and are wanted for table use they should be put in small dry coops and well fed for about a fortnight to three weeks before killing. This procedure will increase the amount of flesh. Most of the chickens seen on the table in Malaya have not been treated in this manner and therefore the proportion of bone is rather large.

In conclusion, it may be mentioned that the importation of good birds is usually disappointing. They are often so badly treated in transit that it is almost impossible to secure their recovery without experience in poultry keeping, and beginners are strongly advised to obtain stock or eggs from acclimatised birds.

The following quotation from "*The National Poultry Journal, 2nd December, 1921*" will be of interest to many "His Royal Highness the Prince of Wales obtained his first utility card, in Breeding Trios at Trowbridge, it was a "Commended" for a trio of *Rhode Island Reds.*"

Diseases and Pests.

Fungoid and Bacterial Diseases.

Insect Pests.

Inspection and Control.

CHAPTER XVII.

Diseases and Pests.

THE study of fungoid and bacterial diseases in their true relation to extensive cultivations is of comparatively recent date and it is only during the last two decades that the losses accruing to cultivators have been realised and approximately estimated. The extent of the losses caused by the crop diseases is illustrated by the following figures given by various authorities in America.

		Gold.
(1)	California Vine Disease in 1892 ...	$10,000,000
(2)	Wheat Rust in United States 1898 ...	67,000,000
(3)	Wheat Rust in Illinois in 1885 ...	1,875,000
(4)	Potato late blight in New York 1904 ...	10,000,000
(5)	Potato Blight in United States (annual)	36,000,000

Nature of Fungi and Bacteria.—Fungi and bacteria are plants low in the scale of organisation and cause disease in higher plants by penetrating the tissues of the latter and extracting food material from them. The plant body of a fungus is composed of ramifying threads, which can usually grow rapidly once they have prnetrated the host plant. Branches are produced from these ramifying threads, which enter cells of the host plant where food material is stored;

from these cells the fungus extracts nutriment required by the host plant, and as a result the vitality of the latter may be considerably reduced. Bacteria are usually single-celled organisms which have the power of multiplying very rapidly. The bacterial diseases of plants as compared with Fungus diseases are few in number, but in some cases cause large losses.

Parasitism and Saprophytism :—The plant kingdom can be very roughly divided into two large divisions.

(*a*) Green Plants.

(*b*) Non-green Plants (Fungi and Flowering parasites). This division is physiological, the green colour in plants being due to the presence of a substance known as Chlorophyll. The presence of chlorophyll enables a plant to utilise the carbon dioxide of the atmosphere under the influence of light. The carbon dioxide together with water and other food materials supplied through the roots enables the plant to build up the organic compounds, sugar, starch, protein etc. which form the basic substances upon which growth depends Fungi possess no chlorophyll and therefore must look to sources other than the atmosphere for their organic food. They possess the power of breaking up very complex organic food materials into simpler compounds which they can then utilise for development. Some fungi are incapable of attacking living tissues and live on dead or decaying organic material, these are termed saprophytos. Others attack living tissues and are called parasites. It is with this latter class that this article chiefly deals.

Wound Parasites and Holo-Parasites :—Parasitic fungi can again be roughly divided into two classes :—

(a) *Wound Parasites* which can only cause damage when the host plant is wounded, the wound forming the point of entry, e.g., in the case of branches broken by the wind.

(b) *Holo-Parasites* which attack undamaged host plants.

The latter class is obviously the more dangerous.

Plantation Conditions in Relation to Rapid Spread of Diseases. Before proceeding to deal with specific crop diseases of local interest, it may be instructive to indicate the chief reason why plant diseases become more dangerous when a jungle tree, such as the rubber tree, is cultivated under plantation conditions. In the natural forests every tree is a surviver in the struggle for existence and only

the hardiest individuals come to maturity. In the jungle the mature trees or groups of trees of any single species are usually separated from the individuals of the same species by trees of widely differing constitution. Specialization or liking for one individual host or at most a narrow range of hosts, is a well known phenomenon in the case of parasitic fungi, so that under jungle conditions, a diseased tree may be found but the fungus causing it cannot attack the neighbouring trees because their constitution is so widely different from that of the attacked tree. Plantation conditions are diametrically opposed to those of the jungle—the struggle for existence does not operate to the same extent since each seedling plant has similar conditions and many comparatively weak individuals survive. The weak individuals may be attacked more easily by disease, and since each tree has a similar constitution to its neighbour, every single tree in the plantation may become infected. Plantation conditions, as a rule, favour rapid spread of disease and it is easy to realise that the greatest care is necessary in the case of the cultivation of a jungle plant taken from its native habitat.

Fungus Diseases of Rubber.

Prior to 1912 little definite research work had been carried out on the diseases of the rubber tree. During the last decade, however, may investigators have been engaged on disease problems wherever *Hevea brasiliensis* has been established on a large scale, so that our knowledge of the more important aspects of rubber diseases is fairly extensive. It is important to mention here that information obtained in respect of diseases in one country does not necessarily apply, without modification, to other countries. Growth conditions in different countries may vary enormously, and this may influence the conclusions to be drawn from any research to such an extent that any recommendations may apply only in the country concerned. Any conclusions stated in this article must, therefore, be regarded as not necessarily applicable to countries other than Malaya.

Rubber diseases in Malaya can be divided as under:—

(*a*) Root diseases.

(*b*) Stem and branch diseases.

(*c*) Bark diseases.

The above divisions are self-explanatory with the exception of (*c*). Bark diseases are so called because they occur when the tree is tapped for the extraction of latex. The latex flows from the cortical tissues when a thin pairing of cortex is excised by the tapping knife. The tapping is done at regular intervals, usually once per day or once every two days, and each tapping exposes a thin strip of tender tissue and forms a suitable place of entry for certain fungi. Bark diseases are, therefore, diseases of the tapped surface.

Root Diseases. In dealing with root diseases reference must be made to the method of opening up the land previous to planting. Most Malayan plantations are started on virgin jungle land. The jungle trees are felled, leaving the stumps in the ground, and the luxuriant undergrowth is cut down. After a period of dry weather the timber and dried undergrowth over the felled area are fired. After the fire the stumps and large logs, though much charred, still remain and during decay form suitable food material for fungi. The original source of the root diseases of *Hevea Brasiliensis* can be traced to the jungle stumps and logs left on and in the ground. If the land were cleared thorpughly before planting it could be stated definitely that root diseases would be negligible on Malayan rubber plantations.

The following root diseases have been investigated in Malaya and the brief description given in each case may be useful for identifying the various affections.

(1) Attacked roots show conspicuous white, ramifying mycelial strands on the outside; common on young trees—

Fomes Lignosus.

(2) Attacked roots show, when the bark is carefully lifted from the wood, black flattened mycelial strands; common in coast land; soil round the roots, when dug up, often having a very bad odour; attacks trees of all ages :—

Sphaerostilbe repens.

(3) Roots attacked by dry rot, diseased tissue dry and tindery, in advanced cases can be crumbled easily between the fingers, usually shews numerous conspicuous black lines running through the rotted wood; common on old trees, *i.e.*, over eight years of age :—

Ustulina Zonata.

(4) Roots attacked by a wet rot; diseased tissue when freshly dug from soil always moist; brownish lines, not very numerous or conspicuous, often present; seldom appears above ground level, found on old trees;—

Fomes pseudo-ferreus.

(5) Attacked roots covered with a hard encrusting mass of earth and stones which is removed with difficulty; not common in Malay, but found on trees of all ages.

Brown root disease.

Fomes Lignosus (*Semitostus*):—This fungus causes most damage on young plantations with trees under seven years of age. Occasionally in localised areas it has caused considerable devastation. Most plantations have suffered loss from this disease; but since owing to close planting the trees have had to be thinned out at the age of six or seven years, the loss caused by this disease has not in the past had serious consequences.

The distinguishing characteristic of this fungus is the white external rhizormorphic strands running over the lateral roots of the tree. The fruit bodies are remarkable in being persistently sterile, while similar fruit-bodies of closely allied species produce millions of spores each capable of infecting a healthy tree under suitable conditions.

Sphaerostilbe repens:—This fungus causes a root disease of rubber trees of any age growing in acid, water-logged soil, and is most common in the coastal areas. Occasionably this fungus has destroyed large areas of rubber, but usually its action is slow and only individual trees are attacked.

The more characteristic features are the flat, black, interweaving rhizormorphic strands, seen closely adpressed to the wood when the bark is removed from the diseased roots, and the fruits of the fungus, which, when present, are typical though rather minute.

Ustulina Zonate:—This fungus is wide-spread, and numerous cases can be found in many old plantations. The fungus is capable of attacking any part of the tree, i.e. root, stem or branch, if the wood is exposed. It often works in

conjunction with boring beetles; the insects, after penetrating the wood, are followed by the fungus and in such cases the trees are killed very rapidly. The fungus often enters the stem at places where large branches are broken off by the wind or other agencies.

In all cases in which *Ustulina Zonata* is active in tissues of *Hevea brasiliensis* the appearance is the same — a typical dry rot of the woody tissues with numerous conspicuous black lines.

Fomes Pseudo-ferreus (Wet-Root Rot) The action of this fungus on roots of *Hevea brasiliensis* is very distinct from that of *Ustulina Zonata*. *Fomes Pseudo-ferreus* produces a typical "wet-rot," in whatever situation the attacked tree is growing. The disease is very dangerous on account of its subterranean habit, for an attacked tree usually blows over before the disease appears above soil level. When a tree is found attacked by this fungus it may be assumed that a number of neighbouring trees are also affected. This disease has caused large losses on many of the older plantations; it is seldom found on young trees.

The wet-rot of the freshly dug out roots together with the inconspicuous brownish lines in the attacked tissues serve to diagnose the attacks of this fungus.

Brown Root disease.—This is not a common disease on rubber but the appearance of attacked roots is quite typical. The mycelium of the fungus binds up earth and stones in the immediate proximity of the roots to form a firm encrusting mass, which is detached with difficulty. The Brown Root disease is a common feature in other tropical cultivations, e.g. tea, coffee, camphor, which will show similar symptoms. This disease is under investigation at the present time, but little definite information has been obtained.

Stem and Branch Diseases. Only two stem and branch diseases require to be mentioned, viz. Pink disease and Die-back disease.

Pink Disease:—This disease is caused by a fungus known as *Corticium salmonicolor,* which on *Hevea brasiliensis* shows varied manifestations. Prior to 1912 the disease was common in only three small centres but in 1913-14, it assumed epidemic form, and spread rapidly, practically throughout the whole Peninsula.

The name, Pink Disease, is associated with the com monest appearance, a continuous pink incrustation covering the attacked branches. The other manifestation, which calls for most attention, is the "Necator" stage which occurs in the form of a series of *orange red* pustules. These are made up of cells which vary much in size; under suitable conditions the component cells break apart and are blown about as single celled spores. The "Necator" was originally believed to be a fungus different from that causing Pink disease, and was named *Necator decretus.*

(b) *Diplodia cacaoicola:*—"Die-back Disease." The fungus, *Diplodia cacaoicola* is a wound parasite which can enter throughthe smallest wounds and is a common disease in all plantations, more especially when growth conditions are adverse. After this fungus has entered the tissues it passes up and down the water conducting vessels very rapidly, and prevents the upward passage of water to the leaves, which wilt and die. The threads of the fungus, dark in colour, cause a pronounced ashy-grey discoloration in attacked wood, which is very characteristic. A noticeable feature, at times, is the association of this fungus with lightning; a group of trees is scorched by lightning and *Diplodia* enters the scorched tissues to grow very rapidly, so that in a few days a group of dead, leafless trees is found.

Bark Diseases. Before 1916 Malayan rubber plantations had not suffered seriously from bark diseases, though plantations in Java and Ceylon had been severely affected for many years. The most prevalent disease, previous to 1916 was "Black Stripe" disease, the fungus held responsible being a species of Phytophthora.

Black Stripe:—This disease assumed epidemic proportions in certain districts in Malaya in 1916. A *Phytophthora* was isolated and shown to be the cause of the disease. Weather conditions play a large part in determining the appearance of Black Stripe epidemics, continued damp and misty mornings being exceptionally favourable to the fungus. A dry weather period assists in bringing the disease under control.

"*Mouldy Rot.*"—This disease caused by the fungus *Sphaeronema fimbriatum,* is a serious disease of the tapped bark of rubber trees in Malaya. It has recently been reported from Java, associated with outbreaks of Black Stripe disease. Until two years ago the disease was very localised, but recently there has been a serious extension of the area

affected by the fungus. It is proving a difficult disease to control, and will undoubtedly be a serious factor on many Malayan rubber plantations.

Brown Bast :—This bark affection has attained considerable prominence during the last few years, one of the most interesting features to the layman being that no investigator has yet succeeded in establishing a definite organic cause, i.e. fungus or bacterium. The generally accepted opinion is that no parasitic organism is concerned, but that the affection represents a morbid physiological condition which is influenced by excessive tapping. The symptoms are difficult to describe briefly, but the ultimate result of a Brown Bast attack is the cessation of latex flow from the tapping cut. All dry trees must be suspected, but it may be pointed out that trees often cease to yield latex from causes other than Brown Bast. Numerous experiments are in progress in most rubber growing countries to determine the factors influencing the development of this bark affection.

Spotting of Prepared Rubber:—During the years 1911-1913 planters experienced much trouble owing to coloured " spots " and " flushes " appearing in their rubber, particularly pale crepe rubber, in the drying sheds. These discolorations have been proved to be due to minute fungi and bacteria, which, growing in the moist rubber, produce red, yellow or violet pigments. These fungal and bacterial discolorations still appear sporadically, but outbreaks are now usually controlled fairly easily, since it is known that the " disease " is invariably due to bad conditions in the drying rooms.

Diseases of Coconut Palms.

In Malaya coconut palm diseases have not hitherto called for much attention. The general situation in respect of coconut plantations is the opposite to that of rubber. The coconut palm is indigenous to Malaya or was introduced naturally, and grows crowded together along river banks owing to the fruits being suitable for water dispersal, and Plantation conditions more or less simulate those obtaining in nature. It is therefore probable that no physiological strain is imposed under plantation conditions, and the trees have every chance of developing along the proper lines.

A few diseases of coconuts, the most important of which is Bud-Rot, require mention.

Bud-Rot ;—" Bud-Rot " is ageneral term and the disease has been recorded on most palms e.g. Areca Palm, African

Oil Palm and Palmyra Palm. The mature leaves of palms surround the growing point, forming a very substantial protective sheath. The growing point, from which the newly developing leaves arise, is part of a large mass of spongy tissue, very rich in food materials, known as the cabbage or bud. If this bud is injured in any way, and micro-organisms effect an entry, a rapid rot is caused and the firm bud tissues disintegrate to a soft, pulpy, evil-smelling mass, the growing point being involved in the general destruction. The evil odour indicates the rapid putrefaction, which is being caused by different kinds of fungi and bacteria. When the tissue of the growing point is wholly destroyed, no further growth can take place and the palm dies.

" Bud-Rot " is an epidemic disease in the Philippines and the West Indies, but no epidemics have been reported in Malaya. The cause of Bud-Rot in the Philippines is said to be the fungus *Phytophthora faberi*: in India and the West Indies, *Phytophthora palmivora*. Observations in Malaya suggest that more investigation is necessary before a definite cause can be assigned. Inoculations on Oil Palms and Coconut Palms with both the above mentioned species of phytophthora have so far, proved unsuccessful in Malaya.

Pestalozzia palmarum:—This fungus is present wherever Coconut Palms are grown in Malaya. Healthy palms suffer little damage although the fungus may be growing on the leaves, but if the palms are growing under adverse conditions a serious set back is often caused. Large portions of the leaf tissue are killed and the fruit bodies of the fungus appear as minute, black elevations about the size of a pin's head, in the dead leaf tissue. The fungus also attacks the African Oil Palm.

Helminthosporium incurvatum:—The fungus—*Helminthosporium incurvatum* is not commonly found attacking palms in Malaya, but on two occasions has caused some trouble. The attacked palm-leaves generally present a scorched appearance, and if the blackened portions are carefully scraped, the hyphae and typical spores of the fungus are found. This fungus has also been observed on African Oil Palms.

Many other interesting diseases of coconut palms have been noted but not investigated. The above mentioned diseases of the coconut palm are often found attacking the African Oil Palm. A peculiar disease also found on young African Oil Palms has been noted, the cause of which is

obscure. In the early stages, from the first to the third year the third leaf from the centre collapses at the base. This is followed gradually by the collapse of the outer leaves, so that finally only a single central leaf may be standing rigid. The youngest central leaves are left uninjured, and growth continues. Normal new leaves are developed, so that the final appearance is of a number of collapsed diseased leaves, below a normal development of rigid leaves. The tree is, perhaps, put back for twelve months, but finally recovers.

Diseases of other Crops.

During the last two years much attention has been given to the possibility of establishing agricultural industries, other than rubber and coconut cultivation, on an economic scale. The cultivation of the African Oil Palm is promising and the diseases so far encountered are similar to those of the coconut palm. Fibre plants of the Agave family have claimed considerable attention, but the leaves of these plants are generally strong and leathery, and do not form attractive feeding places for fungi. The plant *Hibiscus sabdariffa* (*var altissima*), from which Roselle fibre is obtained, appears very subject to eel-worm attacks, and a bacterial disease has also been noted.

Wither-tip, a serious disease in the West Indies, has been observed on lime trees, which are now being cultivated on a plantation scale, but is causing little damage. A root disease, with symptoms similar to those shown in the case of rubber roots attacked by *Ustulina zonata,* has been under investigation. It is to be expected that the serious root disease of lime in the West Indies caused by *Rosellinia bunodes* will be found in Malaya; this fungus has already been found killing young "Kapur" stumps in this country. Pink disease has also been recorded on lime trees in Malaya.

Specimens of diseased Banana plants, Sea Island Cotton, and Castor Oil plants, have been received for investigation. It may be expected that, if any of these crops are planted on a large scale in Malaya, serious plant diseases will appear.

Full details in respect of these diseases, together with control measures, are described in various publications issued by the Department of Agriculture.

Insect Pests.

Considerable information concerning some of the important and common insect pests found on economic crops in Malaya has been accumulated in investigations carried out in the Entomological laboratories of the Department of Agriculture and many doubtful points have been cleared up.

Coconut Pests.

The insects attacking coconuts in Malaya which have been or are being studied in detail are (1) "Red Stripe" Weevil-*Rhynchophorus schach,* Oliv., (2) Black or Rhinoceros beetle, *Oryctes rhinoceros,* Linn., (3) *Plesispa reichei, Chap,* and (4)*Brachartona catoxantha, Hamps,*

"Red Stripe" Weevil. *Rhynchophorus schach,* Oliv.

This weevil is generally known in Malaya as the "Red" weevil, but in view of the fact that the insect is black and possesses a red strip on the mid-dorsal line of the thorax, it is considered that "red stripe" weevil is a more descriptive name than "red" weevil.

Most coconut cultivators are acquainted with the work of this insect and have general ideas of its control, but knowledge of the time taken for the various stages of development and of its habits is deficient.

A few of the more important and interesting facts in connection with this pest, which have been proved by experiments carried out recently at the Department of Agriculture, are as follows :—

(a) The Red Stripe weevil cannot lay its eggs in sound trees, but the palms must have been previously injured in some manner before being attacked. The details of these experiments will be published later.

(b) One-day-old "red stripe" weevil grubs, placed in varying lengths of petioles, have lived in this tissue for several months. The growth of the larva is retarded but since this material is suitable, the possibility of the grub obtaining access to palms through the cut ends of petioles shold not be overlooked.

(c) The maximum number of eggs obtained from a reared female in captivity is 379.

(d) The females are capable of laying eggs on the day after they emerge from cocoons.

(e) The minimum length of time found for the incubation of the egg is two days; from the hatching of the egg to the forming of the cocoon ninety nine days, and from cocooning to the emergence of the adult twenty nine days, making a minimum total of one hundred and thirty one days from the laying of the egg to the emergence of the adult.

(f) Previous to pupating, the larvae remain in the cocoon on an average five days, the pupal stage lasts about thirteen days, and the beetles, after emerging from the pupae, remain in the cocoon about thirteen days.

(g) The adults, both males and females, require food. Weevils without food die in two or three days, and with food may live for 70 days.

(h) Weevils fly during the day time and have been observed at mid-day under natural conditions flying around a damaged palm.

(j) A weevil has been observed laying eggs in the cut end of a petiole.

(k) African Oil Palms in Malaya have been killed by the grubs of this insect.

(l) The control measures consist in preventing injury to palms either by mechanical or other means and in reducing the number of "red stripe" weevils by destroying dead palms and by employing traps under special circumstances.

The Black or Rhinoceros Beetle. *Oryctes rhinoceros Linn.*

Investigations on the Rhinoceros beetle are in progress, the results of which are incomplete, but information concerning some of the doubtful points in the life cycle of this insect has already been obtained and some of the results are recorded below.

(a) The eggs of Oryctes have been laid by beetles in captivity and during the incubation period have been found to increase to about twice their original size.

(b) The largest number of eggs obtained from one female is fifty two.

(c) The length of the larval stage has been variously stated as from twelve to twenty four months, but an example of the complete life cycle of this insect worked out in the Entomological laboratory of the Department of Agriculture, F.M.S. and S.S. is as follows :—

Egg stage	...	11 days
Larva to cocooning ...	...	97 „
Cocooning to pupation	...	10 „
Pupa to adult condition	...	22 „
Adult to emergence from cocoon ...		9 „
Total		149 days

In this case the larval stage lasted one hundred and seven days or roughly three and a half months, including the ten days of the larval life in the cocoon, prior to changing to the pupa. It will be seen that this insect attained full adult condition from the egg in five months.

(d) The chief breeding places for the grubs of the black beetle are village refuse and decaying palms.

Attention has been directed to the most suitable method of disposal of such material.

Village refuse heaps, which have always been causes of complaint and difficult to deal with, may be burned in simply constructed incinerators composed of kerosene tins. The construction and cost of a cheap and suitable incinerator for burning rubbish is described fully in the Agricultural Bulletin, F.M.S. Vol. IX No. 4, but it may be mentioned that four days accumulation of fresh market refuse from a village was burnt in about three hours, and a heap of such material, which had been accumulating for about one year, and which was wet and dense, was destroyed in three weeks.

Dead and decaying palms should be cut into lengths of about one yard, split into several pieces, piled to obtain the best drying effect, and then burnt. Burning is preferable

to burying, especially in coconut plantations, since the burying of dead coconut trees may expose the living trees to the agent responsible for the death of the buried palms.

Plesispa reichei, Chap Considerable information has been accumulated in the study of this insect as a pest of young coconut trees in Malaya.

A manuscript is nearing completion but a few observations may be recorded here.

The beetle is generally distributed and known to most coconut planters. It may be recognised by its flat shape, yellowish thorax and black wing covers.

The beetles and grubs, which are also flat and of a dull yellow colour, feed between the folds of the opening leaflets and between the leaflets.

The brownish coloured eggs are laid singly by the females on the young coconut leaves. The grubs hatching from the eggs feed on the leaves.

Fresh feeding marks are seen in a straight line parallel to the veins. Later the feeding marks mingle with each other until the mesophyll (middle tissue) of the leaf alone remains. Decay sets in, the tissue of the leaf collapses, and the plant takes on a barren and wind-beaten appearance. The following is a synopsis of the life history.

Eggs to Larvae	...	... 7-10 days. The majority of the eggs hatch in 7 days.
Larvae to Pupae	...	... 30-38 days. The majority of the grubs take 33 days.
Pupae to Adults	...	... 7-8 days. The majority of the pupae are in the pupae state for 7 days.

Interesting biological observations have been made; one female deposited 112 eggs in 249 days; one female lived 287 days and a male 273 days; the age of a female at first oviposition varies, the minimum age found is 28 and the maximum 58 days.

Plesispa reichei has been found damaging older trees but injury is not so marked as in the case of seedlings and young palms. Trees up to twelve years old have been attacked, but in most cases previous injury to the crowns was observed or the trees were growing under unhealthy conditions.

Control Measures:—The measures for the control of this insect should be, as far as possible, preventive.

Seedlings when planted in the field should be free from eggs, grubs, pupae, and adults of Plesispa.

Nurseries should not be made under coconut trees, but should be prepared in an empty space or under any other trees. On an estate where Plesispa was present in large numbers, seedlings of two months, planted under coconut trees, showed the presence of beetles, whilst under rubber trees not far removed, seedlings of six months were free from beetles.

Previous to planting or supplying, seedlings should be carefully examined, and the beetles and grubs if present in small numbers should be hand collected, but if in large numbers the seedlings should be immersed twice at an interval of eight days in a solution of Lead Arsenate at a strength of two lbs. to fifty gallons of water.

Immersion will not only wash a large percentage of the adults from the plants but will kill the remainder and render the plants distasteful to the insect.

Immersion of the plants twice at an interval of eight days is necessary to kill the grubs which may have hatched from eggs after the first treatment.

When the insects are present on young palms in the field, an application of the solution of Lead Arsenate by spraying well into the centre of the plant once every three weeks will probably be found cheaper and more efficient than hand collection.

(4) *Brachartona catoxantha*, Hamps:—The caterpillars of this pest cause considerable damage at intervals to coconuts, but, chiefly owing to the difficulty attending the use of ordinary knapsack sprayers, and the unsuitability of the ground for power sprayers, in dealing with outbreaks on large trees recently, other methods have been tried.

The most promising method is the distribution of the fungus which usually controls this insect under natural con-

ditions. Leaves on which Brachartona had been killed by a fungus in one part of Malaya have been transported to a place where no fungus was present to control this insect. The result is encouraging, but before definite statements can be made much more experimental work will have to be performed, and the large question of cultivating the fungus in the laboratory for immediate use when required will necessitate prolonged and continuous research work.

Insect Pests on Rubber Trees.

The insects of significant economic importance attacking rubber are very few. There is at present no serious pest of rubber to cause anxiety but planters are advised to be always on the alert in case some of the insects of minor importance should reach grave proportions.

(a) *Coptotermes gestroi* (White ants) is still the most important pest of rubber, but the general control measures of clean clearing and the destruction of buried timber have proved satisfactory. The heat from the "white ant" pump which is used extensively for the treatment of this pest often causes injury by burning the bark but this is due chiefly to the carelessness of the worker.

(b) Instances of caterpillars attacking the leaves of rubber have been noted during the past few months. In one case, caterpillars, having eaten the leaves of the castor oil plant, migrated to young rubber. Hand collection and spraying measures with solution of Lead Arsenate have been adopted with success. In another case, caterpillars of *Tiracola plagiata* left blukar and seriously attacked young rubber trees. Isolation of the blukar from the rubber by digging a trench with a sloping side near the blukar and an upright side near the rubber gave satisfactory results.

It is not considered advisable to grow the castor oil plant as a catch crop on rubber estates. On clearings an isolation trench about ¾ yard deep by ½ yard wide should be considered.

(c) Mealy bugs, which cause considerable damage to a large variety of plants, have been noted attacking rubber plants, but only in isolated cases.

(d) Bark-eating caterpillars—species of "bag-worms" (*Psychidæ*) and caterpillars, resembling two *Karingas* joined

together, have been reported doing damage to the tapping surface and should be viewed with suspicion.

(e) A number of insects has been observed feeding on the inflorescence of the rubber tree. The principal one is a caterpillar of the moth, *Hemithea costipunctata*. Moore. The habits of this insect on the rubber tree have been recorded recently in the Agricultural Bulletin, F.M.S. and only a brief synopsis is given here.

The eggs are flat and cylindrical in shape and light geen in colour. They are laid usually singly but occasionally in twos or threes one above the other on the flowers and stalks of the inflorescence. The eggs hatch in two to four days, usually in three days.

The larva, emerging from the egg, is greenish in colour with three distinct lines running longitudinally along the body. It is a true " looper " possessing three pairs of thoracic legs and two pairs of pro-legs.

The caterpillar is difficult to distinguish throughout its larval stage since in colour it resembles an inflorescence and, in appearance, when at rest, a flower stalk; when full grown it measures about one inch, and attains this condition in from seventeen to twenty five days.

The pupae are seen suspended by their anal ends among the inflorescences. The pupa is about half an inch in length, the general colour at first is pale green but later this changes to dark green with blackish spots.

The moth emerges from the pupa in from eight to eleven days. It has a wing expanse of about ¾ inch, the upper surface of the wings being cobalt green in colour with three white silvery wavy lines. The under surface of the wings is silvery green in colour. The moth lays eggs four or five days after emergence from the pupa.

The life cycle from the laying of the egg to the emergence of the adult occupies from twenty eight to thirty two days.

In the laboratory, the caterpillars have occasionally fed to a very slight extent on the young tender leaves but they chiefly confine their attention to the flowers.

This insect was first found near Teluk Anson and has been obtained at Kuala Lumpur between January and December in the field.

Until there is a large demand for rubber seed for the purpose of extracting oil, this insect is not of economic importance but in case it changes its habit and commences to feed on the young leaves of rubber it should be kept under continuous observation.

Insect pests of padi.

The pests of padi have received considerable attention and much progress has been made in their study.

They may be conveniently divided into sucking insects, 'borers', and leaf-eating caterpillars.

(1) *Sucking Insects:*—The sucking insects belong to the *Rhynchota* and this order is well represented in *Podops coarctata,* Fabr., *Leptocorisa varicornis,* Fb., *Nezara viridula* Linn., and *Nephotettix bipunctatus*, Fb., The most important are *Podops,* ("Kutu bruang") and *Leptocorisa,* ("Pianggang",) and although the others attain local significance from time to time, enquiries concerning the major pests have been more numerous and detailed investigations have been confined to these.

There are no references in entomological literature concerning any of the above insects in Malaya.

Podops coarctata, Fabr. This insect, commonly called in Malaya " Kutu bruang " is black in colour, about ½ inch in length, and slightly less in breadth, and belongs to the family *Pentatomidae* or "stink" bugs. The nymphs and adults suck the sap from the plant and when present in large numbers so weaken it that no grain is produced.

The eggs, in varying numbers, are laid in groups, usually near the base of the plants. The adult has the habit of remaining on the eggs until they hatch, probably in order to protect them from egg parasites. Frequently, young nymphs are seen clasping the adults, and in this manner are transported to other plants.

There is a slight variation in the time taken for the hatching of the eggs in one egg mass, and from one group to another, but it is usually about five days.

The young nymphs after hatching are often seen remainning for several days on the egg cases.

There are five moults before the nymphs attain the adult condition, and the breeding records show a variation of from twenty eight to fifty four days, although the majority take from thirty to forty days, from the emergence of the nymphs from the egg until the adult condition is reached.

This insect has been found on land just previous to planting padi, showing that it is capable of existing on the stubble and growth from the previous crop.

Control measures:—No satisfactory control measure has been found for this insect where water is not available.

Spraying experiments with kerosene emulsion and extract of tuba root have been conducted under field conditions, but no definite results have been obtained.

Podops coarctata is attracted to light but when light traps have been tried, the number of the insects caught has been so few in comparison with the adults in the field that this method of control cannot be recommended.

During the study of this insect, it has been observed that when padi was flooded, the nymphs and adults came to the surface of the water. This habit has been utilised on a number of occasions and where a supply of water has been available, the flooding of the padi and collection of the insects on the surface of the water has in every instance proved successful.

Eggs, nymphs and adults are found in the nursery beds and, if more attention were paid to planting out clean seedling padi plants, the chances of outbreaks of *Podops* would be reduced.

The eggs of *Podops* are frequently highly parasitised and should be kept, in order to ascertain if parasites are present. If parasites are obtained, the egg masses should be placed in a tray, having a groove around the circumference in which water with a small quantity of kerosene oil is poured. The nymphs emerging from unparasitised eggs would be unable to cross the barrier of kerosene, and the parasitic flies would escape to continue their useful control work.

Leptocorisa varicornis Fabr.:—There is probably no insect pest of padi which is capable of causing so much serious loss and damage to the crop, as *Leptocorisa varicornis,* Fabr. It belongs to the family of bugs *Coreidae* and is recognised by

its greenish brown colour, elongated body and its habit of sucking the sap out of the developing grain.

This insect, called in Malay "Pianggang", lays the majority of its eggs on the upper surface of the leaves. The eggs are brownish in colour and are very conspicuous, being laid in chain formation parallel to the mid-rib. The eggs usually hatch in seven days and the nymphs, which are distinctly green, commence to feed, after a short time, on the ripening grain. The nymphs moult five times before reaching the adult or winged stage. The breeding records at the present time show that from the hatching of the egg to the adult stage a period of from fourteen to nineteen days elapses.

The insect is capable of living on the inflorescences of various grasses and after the padi is harvested, such grasses provide food until the ripening padi seed is ready again to be attacked.

Control Measures:—A number of suggestions may be made concerning the control of this insect, but preventive measures in the nature of keeping down grasses in the vicinity of the growing padi and on the "bendangs" between the padi seasons should be strictly practised.

When attacking the crop, the insects may be reduced by use of hand-nets or by drawing elongated bags previously coated with some sticky material like crude oil emulsion quickly across the field.

The eggs are conspicuous on the leaves and should be collected.

It is said that *Leptorcorisa,* attracted by the odour, congregate on putrid meat. If this method is practised, the insects on the bait can be burnt by means of a torch.

Further experiments are required to ascertain the best methods to adopt for the control of this insect and the larger question of growing resistant varieties of padi may have to be considered.

(2) *Borers*:—Two Pyralid c aterpillars, viz, *Schoenobius bipunctifer*, Wlk, and a species of *Diatraea* are "borers" which are being investigated. The latter, which was more prominent than *Schoenobius* in the earlier

part of the padi season in the Krian district in 1921, had not been recorded previously as a pest of this crop in Malaya.

(3) *Leaf-Eating Caterpillars :*—A large variety of caterpillars included as leaf-eating caterpillars are usually present and from time to time do considerable damage to padi.

Larvae of *Parnara mathias,* Fb., which roll the leaves of padi and feed inside them, of *Melanitis ismene,* Cram, of *Nymphula depunctalis,* Gn, which are semi-aquatic and live in cases made of rolled pieces of leaf, and of *Spodoptera pecten,* Gn, which are likely to increase very quickly in enormous numbers, have so far received only a little attention.

Control of Padi Insects :—This summary of investigations of padi pests is very brief, and a few remarks concerning general control are considered desirable in closing this article.

The methods employed for the preparation of the land for padi take no account of insect pests, which are responsible for an enormous loss of grain from year to year. Good crops are obtained but in a large number of cases it is doubtful whether a crop equivalent to the amount of padi sown is harvested. This result is generally caused through the agency of the insects.

From an entomological point of view, the practice of allowing stubble and self-sown padi to grow, after harvesting the crop, is strongly deprecated. Ideal conditions are maintained for insects to remain and propagate until the next paid is sown.

Many of the more important pests of padi feed on wild grasses, and whilst grasses are allowed to grow they provide suitable breeding grounds for insects to attack the new crop of padi, and outbreaks of pests will be likely to occur where the grasses are not destroyed.

The eggs of those insects liable to do most damage to padi, viz:—*Podops, Schoenobius, Leptocorisa,* and *Spodoptera,* are conspicuous on the leaves and should be collected whenever seen. They are frequently present on nursery plants, and, on account of the cultivators' ignorance, are taken to the field with the seedlings.

Miscellaneous Insect Pests.

Pests of many plants of lesser importance such as Sugar Cane, Castor, Limes, African Oil Palm, Rotan, Gutta-percha, Bamboo, Banana, Roselle, Maize, Indigo, Cotton and various vegetables have come under the notice of the entomological section and observations concerning them have been made. Detailed studies of most of these insects have, however, not yet been carried out.

The Malayan Locust:—Locusts, *Pachytylus, sp.* first appeared in the coast district of Negri Sembilan early in 1912 near Port Dickson. They spread rapidly into Negri Sembilan, northward into Selangor and southward into Malacca. In August 1913 the work of destroying them was commenced by a special staff organised and controlled by the Chief Agricultural Inspector and the Assistant Inspectors of the Department of Agriculture. The methods employed were recommended and tested by the Government Entomologist of the Department. "Hoppers" only were destroyed. The methods used were to drive the hoppers down a V-shaped enclosure into a bag-trap, and to spray the grass on which they were feeding with a solution of commercial arsenite of soda and sugar. The spraying method was the more successful and cheaper, and was always used except where cattle were numerous, as in Malacca. An account of these methods and of the life-history of the locust will be found in Bulletin No. 24, of the Department of Agriculture, F.M.S. "The Malayan Locust."

The average time from the laying of the egg to the emergence of the adult insect was forty-one days. The flying insects lived for about three months, after which they laid eggs and died. This gives a total life-cycle of about 130 days.

The locusts spread as far north as the Selangor—Perak boundary. At the end of 1914 they entered the north of Johore, and once in September 1914, and again in September, 1916, they entered Pahang, travelling up the railway line into the Temerloh district.

Selangor was freed of locusts by the middle of 1916, and their numbers everywhere were steadily reduced until the last swarm of hoppers known was destroyed in Malacca in October, 1917. A few flying swarms remained on the Malacca—Johore boundary until the middle of 1919. None of these laid eggs and all swarms slowly diminished in

numbers until they finally died out and disappeared. None have been seen since June, 1919.

The locusts did not feed on rubber, but occasionally damaged trees by settling on them and breaking the branches by their weight. The crops damaged were rice and coconuts, but the principal food-plants were bamboos; sugar-cane, and pineapples were also eaten, and it was interesting to see the rapidity with which the insects would destroy the appearance of a bamboo hedge or turn a green lawn brown. Food supplies were abundant, so that the locusts were never omnivorous, but always confined their attention to monocotyledonous plants.

The entire success of the destruction work, combined with their first appearance near a port, suggest that this locust was not a native of the Malay Peninsula, but was imported by some means from an outside country.

Inspection and Control of Pests.

The damage that may be caused by pests when large continuous areas are planted with a single crop is well known from experience gained in many countries. The term "pest" is here used to denote any organism capable of attacking cultivated plants; as defined in the Agricultural Pests Enactment referred to below, and includes insects, invertebrate animals, rodents, plants and fungi, injurious or liable to be injurious to cultivated plants.

Epidemic attacks of such pests on any particular crop may be due (1) to the rapid increase of a known indigenous pest of the crop under conditions peculiarly favourable to its growth; (2) to the fact that an indigenous pest formerly limited to other host plants has become adapted to the crop and on it has attained additional virulence; or (3) to the introduction of pests from other countries that are either themselves of known virulence, or that find the new conditions especially favourable in the absence of the natural controls existing in the country from which they come.

A staff of adequately trained inspecting officers can do much to guard against the attacks of epidemic pests by enforcing control measures generally, by reporting immediately to research officers the discovery of any new pest on a crop, and by preventing the introduction of pests from foreign countries.

Historical Survey:—The danger described and the method of guarding against it have been recognised in part for several years in the Peninsula. Before the introduction of rubber cultivation, coconut palms were generally grown, both on estates in suitable localities, and universally on small holdings throughout the country. These were subject to serious damage caused by two indigenous beetles, the rhinoceros or black beetle, *Oryctes rhinoceros*, Linn., and the red stripe weevil *Rhyncophorus Sach* Oliv. To control these in the Federated Malay States a staff of inspectors was organised under an Inspector of Coconut Plantations, with a staff consisting originally of two European Assistant Inspectors and eighteen Malay Sub-Inspectors; of the latter, one was stationed in each of the principal coconut producing districts. There were also four Sub-Inspectors in the Colony; one in Malacca, one in Singapore,one in Penang and one in Province Wellesley. These Straits officers worked under the Director of Gardens, Singapore, or the local Collector of Land Revenue. The staffs so established administered the provisions of the Coconut Trees Preservation Enactment, 1898, in each of the federated States, and the Coconut Trees Preservation Ordinance, 1890, in the Colony.

These laws required that all coconut trees attacked by beetles should be suitably treated by their owners and that dead coconut trees should be cut down and burnt or buried three feet deep. They also enabled a Collector of Land Revenue, or one of the inspectors referred to above, to serve a notice on any land-owner requiring the destruction or removal of any accumulations of rubbish on his land, such as were liable to form suitable breeding places for these beetles. If the owner failed to destroy dead trees or to comply with the notice, a duly authorised officer could do the work required and recover the cost, while the owner was further liable to a fine.

The rapid development of plantation rubber cultivation rendered it necessary to extend the inspection work to this crop. The opportunity was taken, therefore, to establish a staff of inspectors to control pests generally on all cultivated crops in the Federated Malay States. Provision was made in 1913 for a Chief Agricultural Inspector and four European Assistant Inspectors. In August of that year the Agricultural Pests Enactment, which these officers were to administer, was passed. On the retirement of the Inspector of Coconut Plantations, towards the end of 1913, his staff came under the control of the Chief Agricultural Inspector.

The spread of locusts from the Federated Malay States and the Colony into Johore at the end of 1913 led the Government of Johore to appoint an European Assistant Agricultural Inspector early in 1914. This officer also worked under the Chief Agricultural Inspector, Federated Malay States.

During these and succeeding years, steps were taken to build up a staff of well trained Malay Officers both for inspection purposes and to assist research officers in the laboratory.

In 1918 the Agricultural Department, Federated Malay States took charge of agricultural work in the Colony and a staff of two Europeans Assistant Inspectors with Malay subordinate officers was provided.

Enactments and Ordinances. In the Federated Malay States, The Agricultural Pests Enactment was passed in 1913. This empowers Inspecting Officers to enter on any agricultural land and inspect the plants growing on it. If the cultivated plants are attacked by any pest, or if the land or the plants are in a condition favourable to the introduction and or spread of any pest, the Inspecting officer can order the owner or occupier of the land to take such action as he may consider necessary for the treatment or control of the pest. This order is in the form of a notice stating the action to be taken and the time within which it must be completed. If the owner or occupier fails to do the work satisfactorily, the Inspector can enter the land and have the work done, after which the Director of Agriculture, or his deputy, can recover the cost by civil suit. For wilful neglect to comply with an order the owner or occupier of the land can be prosecuted by the Inspector, if so authorised by the Director, and can be fined. Inspecting Officers can thus control existing known pests of crops and can report promptly to the research officers the appearance of new pests. Thus protection is afforded against indigenous pests. The Enactment also gives the Chief Secretary power to make rules requiring the notification to Inspecting Officers of any pest likely to assume dangerous proportions. It further empowers the Chief Secretary to make rules regulating the importation of plants from outside the country and thus affords protection from introduced pests.

In Johore a similar Enactment was passed in 1914. This is now replaced by a revised Enactment of 1921. In the Colony, The Agricultural Pests Ordinance, No. 25 of 1918, is very similar to the Federated Malay States Enactment.

The Inspecting Officers in the Federated Malay States also administer the Water Hyacinth Enactment, No. 17 of 1917, which provides for the destruction of this noxious weed by the owner of the land on which it is growing, or in the event of his failure to do this, by an Inspecting Officer at the owner's expense.

Rules made by the Governor and by the Chief Secretary published in the Gazettes require the notification to the nearest Assistant Inspector, or to the Chief Agricultural Inspector, of the following pests :—

Brachartona catoxantha Hamps. a caterpillar attacking the leaves of coconuts.

Pink Disease of rubber (*Corticium javanicum* B and Br.)

Mouldy Rot of Rubber *(Sphaeronema sp.)*

Black Stripe of Rubber *(Phytophthora sp.)*

Further rules lay down the conditions under which sugar-cane may be imported into the Colony or the Federated Malay States ; and others prohibit the importation of Para rubber, or any species of Hevea, except with permission of and under the conditions laid down by the Director of Agriculture.

The references are :—Federated Malay States Government Gazette,

Vol. V. December, 19th 1913.

Notification No. 3679 ; Vol. IX. November, 9th, 1917.

Notification No. 3274 ; Vol. XII. July, 16th, 1920.

Notification No. 2943 ; Vol. XIII. August, 26th, 1921.

The Straits Settlements Government Gazette,

Notification No. 3931 No. 67 ; June, 11th, 1920.

Notification No. 1011 ; No. 91 ; August, 27th, 1920.

Notification No. 1495 ; No. 78 ; September, 30th, 1921.

Notification No. 1631.

Control:—The first problem that required attention when the staff was appointed was the control, or destruction of the locusts which were becoming numerous in Selangor, Negri Sembilan, Malacca, and Johore. The special staff appointed for this work was controlled by the Chief Agricultural Inspector and worked under the Assistant Agricultural Inspectors in Selangor, Negri Sembilan and Johore. The locusts were ultimatley entirely exterminated.

At the same time the usual routine work for the control of coconut beetles was maintained in the Federated Malay States. This was soon followed by similar work for the control of Pink Disease of rubber. Later in 1917 Black Stripe and Mouldy Rot of rubber required attention in the Federated Malay States. The work in Johore developed along similar lines but progressed more slowly. General sanitation on estates and small holdings also received attention. This involves mainly the destruction of dead rubber trees by burning and also the prevention of such bad tapping as will render the trees liable to disease. The eradication of lalang on cultivated land was required until the recent fall in prices rendered this impracticable in many instances. In the Colony the principal work has been the control of coconut beetles ; these had became numerous owing to the felling of numbers of coconut trees which were left to rot, and to the accumulation of heaps of rubbish suitable for breeding grounds.

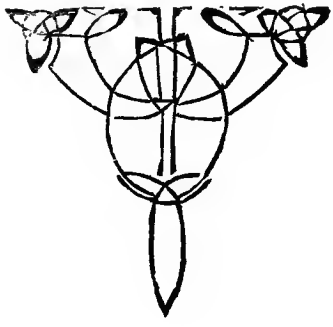
At the present time, in the Federated Malay States and Johore, Pink Disease and Mouldy Rot are the most important pests of rubber requiring constant attention, while in the Federated Malay States and the Colony much time is being devoted to experimental measures for the control of various padi pests.

Naturally any new line of work, or the control of any new pest, requires much instructional work among small holders before measures to enforce action can fairly be taken. Pamphlets and posters in Asiatic languages are issued for this purpose and field demonstrations are given. This educational work is an important function of the Inspecting Officers.

The problems engaging attention at present are the organisation of the measures necessary to control the importation of plants and to ensure the exportation of healthy plants only. It will probably be necessary to establish definite ports of entry at which alone plants may be imported and to provide that all plants coming in are inspected by a

properly qualified officer. This is the usual procedure in other countries. Such an officer generally has power to admit plants, to require their treatment, or to destroy them, as he may deem necessary.

In England, the Destructive Insects and Pests Order, 1921, prohibits the landing from outside of a wide range of plants, unless each package is accompanied by a certificate from a duly authorised person stating that the plants are free from pests, more especially certain pests mentioned in a schedule. Some other countries also have similar legislation. Arrangements are being made to enable the European Inspecting Officers to sign such certificates on the receipt of applications for their services from exporters of plants.



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The following Special Bulletins may be obtained on application to the Department of Agriculture.

1. Notes on *Termes Gestroi* and othes species of Termites found on Rubber Estates in the Federated Malay States, by H. C. Pratt, Government Entomologist, 1909.
2. Root Diseases of *Hevea Brasiliensis*, the Para Rubber Tree, by W. J. Gallagher, Government Mycologist, 1909. Reprint 1916.
3. Observations on *Termes Gestroi* as affecting the Para Rubber Tree and methods to be employed against its Ravages, by H. C. Pratt, Government Entomologist, 1910. Reprint 1916.
4. A Lepidopterous Pest of Coconuts, *Brachartona cotoxantha. Hamps*, (Zygaenidae) by H. C. Pratt, Government Entomologist, 1909.
5. The extermination of Rats in Rice-Fields, by W J. Gallagher, Government Mycologist, 1909. Reprint 1916.
6. Preliminary note on Branch and Stem Disease of *Hevea Brasilienisis*, by W. J. Gallagher ment Mycologist, 1909. Reprint.
7. Coffee Robusta, by W. J. Gallagher, Government Mycologist, 1910.
8. The Cultivation and Care of the Para Rubber Tree (in Malay), 1910.
9. Die-Back Fungus of Para Rubber and of Cacao: by Keith Bancroft, Assistant Mycologist, 1911.
10. A Lecture on the Para Rubber Tree. by W. J. Gallagher, 1910. Reprint 1916.
11. Coconut Cultivation by L. C. Brown, Inspector of Coconut Plantations, 1911.
12. Padi Cultivation in Krian, by H. C. Pratt, Government Entomologist, 1911.
13. A Root Disease of Para Rubber, *Fomes Semitostus;* by Keith Bancroft, Assistant Mycologist, 1912.
14. The Die-Back Disease of Para Rubber and a Note on the Leaf Diseases of Para Rubber; by Keith Bancroft, Assistant Mycologist, 1911.
15. Camphor: its Cultivation and Preparation in the Federated Malay States, by B. J. Eaton, Agricultural Chemist, 1912.
16. The Spotting of Plantation Para Rubber (A Preliminary Account of Investigations on the cause of the Spotting), by Keith Bancroft, Mycologist, 1913.
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20. Agriculture in Malaya, in 1913, by L. Lewton-Brain, Director of Agriculture, 1914.
21. Pink Disease by F. T. Brooks, Mycologist, and A Sharples, Assistant Mycologist, 1915.
22. A Disease of Plantation Rubber caused by *Ustulina Zonata*, by F. T. Brooks, Mycologist, 1915.
23. The Tapping of the Para Rubber Tree by E. Bateson, Assistant Mycologist, 1914.
24. The Malayan Locust, by H. C. Pratt, Government Entomologist and F. de la Mare Norris, Assistant Agricultural Inspector, 1915,
25. *Ustulina Zonata*—a Fungus affecting *Hevea Brasiliensis*, by A. Sharples, Mycologist, 1916.
26. Vegetable Culture in Malaya, by F. G. Spring, Agriculturist and J. N. Milsum, Superintendent Government Plantations, 1917. Second Edition 1919.
27. The Preparation and Vulcanisation of Plantation Para Rubber by B. J. Eaton, Agricultural Chemist, J. Grantham and F. W. F. Day, Assistant Agricultural Chemists, 1918.
28. A Wet Rot of Para Rubber, by W. N. C. Belgrave, Assistant Mycologist, 1919.
29. Fruit Culture in Malaya, by J. N. Milsum, Superintendent Government Plantations, 1919.
30. Food Production in Malaya, by F. G. Spring, Agriculturist, and J. N. Milsum, Acting Assistant Agriculturist, F. M. S. 1919.
31. Black Stripe and Mouldy Rot of *Hevea Brasliensis*, by A. Sharples, W. N. C. Belgrave F. de la M. Norris, and A. G. G. Ellis.
32. Observations on the Technique required in Field Experiments with Rice by H. W. Jack.


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