COLONIAL ADVISORY COUNCIL OF AGRICULTURE
AND ANIMAL HEALTH

C.A.C. 454

REPORT

BY

SIR FRANK STOCKDALE, K.C.M.G., C.B.E.
Agricultural Adviser to the Secretary of State for the Colonies

ON A

VISIT TO MALAYA, JAVA, SUMATRA AND CEYLON 1938

COLONIAL OFFICE,
April, 1939

CONTENTS.

INTRODUCTORY.

This visit to Malaya, the Netherland Indies and Ceylon was made in response to a request from the Governor of the Straits Settlements and High Commissioner for the Malay States who indicated that the Adviser in Agriculture desired to discuss certain matters concerning Malayan agriculture and agricultural policy in the Peninsula generally. After a period of five weeks in Malaya, the tour was extended to Java and Sumatra in order to study the agriculture of the Netherland Indies and the research and advisory services which have been created to serve their agricultural industries. On the homeward journey a short stay was made in Ceylon in order to see the developments which had taken place in the work of the research organisations for the tea, rubber and coconut industries and of the Department of Agriculture since I left the island nearly ten years previously.

The arrangements for the tour in Malaya were made by Mr. O. T. Faulkner, C.M.G., the Director of Agriculture, Straits Settlements, and Adviser in Agriculture, Malay States and I owe thanks to him for making it possible for me to see so much of the Peninsula and for accompanying me on most of my journeys. It was made possible for me to visit some parts of all the Straits Settlements and Malay States with the exception of Perlis and to see agricultural activities under varying conditions. To the Malay Rulers whom I met, the Residents or Advisers in the several States, the staff of the Department of Agriculture and numerous representatives of the planting industries I would wish to express my grateful thanks for their assistance. I was pleased to have had the opportunity to meet representatives of the Cameron Highlands Association and the Department of Agriculture's Advisory Committee. The meeting of this Committee was arranged for the day before I left Malaya and it was therefore possible to consult them on various matters and to consider with them some of the conclusions which had been reached as the result of my tour.

Dr. H. J. Page, M.B.E., the Director of the Rubber Research Institute, arranged for me to see the work of the different branches of that organisation and the latest developments in the rubber industry. I have to thank him and the staff of the Institute for the opportunity given to me to see so much of that important industry in Malaya in so short a time and I am also grateful to the Superintendents of the various estates who showed me their latest plantings of budded rubber and selected seedlings as well as the areas which were being replanted with improved planting material and some of those new areas which had been opened on an experimental basis in collaboration with the Research Institute. Particular attention was devoted to the problems of the smallholders of rubber and to the efforts of the smallholders' advisory service to secure

improvement in production. Visits were also paid to Ladang Geddes and some of the other properties belonging to Messrs. Dunlop Plantations, Limited, and my thanks are due to Mr. Wiseman and Dr. Haines, the technical adviser to that Company, for the interesting visits which were arranged and the profitable discussions on the several properties.

The Eastern Asiatic Company in Singapore arranged for me a display of samples of copra from 19 different localities including a number of copras imported into Singapore from the Netherland Indies. This exhibit enabled me to judge as to the relative grades of copra being prepared in Malaya by estates and by smallholders and the produce of the Netherland Indies which finds its way to the Singapore market. Inspections of copra kilns of various types were also arranged by the Department of Agriculture.

Special attention was given to padi cultivation and in addition to visits to many of the padi experiment and test stations of the Department of Agriculture arrangements were made for visits to developmental works in company with Mr. A. G. Robinson, Director of the Irrigation and Drainage Department, and with members of its staff.

Discussions were also arranged with Mr. R. Boyd, Director of Co-operation, Dr. Whitworth, Director of Veterinary Research, Mr. J. P. Mead, Conservator of Forests, and Mr. A. Keir, who was acting as Director of Education.

The Governor of the Straits Settlements and High Commissioner for the Malay States (Sir Shenton Thomas, G.C.M.G.) also arranged a discussion with Mr. Faulkner and me on agricultural matters generally and considered with us some possible lines of development in the future.

A separate section of the Report is devoted to the visit to the Netherland Indies, the work which is being done by the Agricultural, Educational and Credit sections of the Department of Economic Affairs and by the various crop organisations. In that section I have referred mainly to the research work and the results being obtained therefrom which are likely to be of interest to various parts of the Colonial Empire.

In Ceylon I was afforded the opportunity of seeing recent developments in the work of the three crop research organisations which have been established during the past twelve years and the work of the Department of Agriculture, particularly in connexion with small-holders' agriculture, animal husbandry and fruit cultivation. The Governor, Sir Andrew Caldecott, K.C.M.G., arranged a discussion on agricultural matters generally with the Minister of Agriculture and Lands (Mr. D. S. Senanayake) and the Director of Agriculture (Mr. E. Rodrigo) and the difficulties which were being experienced in connexion with imports into Ceylon of citrus fruit from countries infested with the Mediterranean fruit fly.

The Director of Agriculture accompanied me on visits to various parts of the colony and I am grateful to him for his assistance and for the arrangements made in connexion with my visit. It was a great pleasure to me to meet again the members of the staff of the Department of Agriculture and so many old friends in Ceylon and to have with them discussions on agricultural affairs. I would also wish to thank the Directors of the Tea, Rubber and Coconut Research Stations and their staffs for the details given to me of the progress of work of their respective institutions.

Soil erosion was naturally a matter to which I gave some attention in Ceylon and whilst I feel that there has been a certain amount of improvement in some directions, in the tea growing districts there are estates where deterioration has taken place since I left Ceylon in 1928. It was pleasing to note that the Department of Agriculture had during the past two or three years attempted to interest by demonstration areas small-holders in the necessity for conserving their lands from deterioration and possible destruction by erosion. This effort to interest the small-holders in the necessity for conserving their soil and maintaining its fertility is obviously a move in the right direction and it is to be hoped that all sections of the agricultural community of Ceylon will continue to make every possible endeavour to check soil deterioration by reason of erosion. The problem of soil erosion is the main agricultural problem in the hilly parts of Ceylon and the amount of uncovered land which is to be seen between rows of tea bushes in some estates in the tea-growing districts is still far too high.

By reason of pressure of other work, it has been impossible to complete this Report at an earlier date. It has been prepared during short intervals at week-ends and it is not claimed in any way to be exhaustive. Much that was seen and noted during this interesting and informative tour to Eastern countries has had to be omitted and reference has been made only to those matters which seemed to be of outstanding interest to the Colonial Advisory Council of Agriculture and Animal Health at the present time.

Detailed reference to Animal Husbandry matters in Malaya has been omitted from this Report as this matter is the subject of separate consideration. Attempts are being made to improve dairying and the opportunity was taken to visit the Singapore Dairy, the dairy at Frasers Hill and the newly-constructed dairy premises for the dairymen providing milk to Ipoh. The work of the Department of Agriculture with dairy stock at Serdang, pig-breeding and poultry-keeping was also inspected. Progress is being made in the development of poultry husbandry, but diseases are at times responsible for considerable losses. The Veterinary Department is seriously handicapped

in its research work into poultry and stock diseases by the lack of a suitable laboratory and other facilities for this work. It also has no officer on the staff who is devoting his attention undividedly to veterinary research and it has to rely upon field observations supported by laboratory investigations in the Medical Department. Closer co-operation between the departments concerned with animal husbandry is clearly necessary and desirable,

In Ceylon there has been considerable development of work concerned with animal husbandry and I was afforded the opportunity of visiting stock farms and the central organization for aiding the poultry industry.

Fruit-growing has also made progress in Ceylon during the past ten years and, as will be seen in the Report, I have suggested that greater attention should be given to fruit cultivation in Malaya in order that the requirements of the people of the Peninsula may be met to a greater extent from local production and a demand created for even greater quantities.

MALAYA.

The Malay Peninsula forms the most southerly part of the continent of Asia and lies between 1°12′ and 6°50′ north. In extent its area is 51,070 square miles and unlike the neighbouring countries of Sumatra and Java it contains no volcanoes nor is it liable to violent earth movements. It is a stable country built on an old quartzite bed and a carboniferous calcareous series of rocks. Through the quartzite have appeared intrusions of later granite and outcrops of these occur over large areas.

A backbone of granite mountain ranges arranged in parallel runs from north to south somewhat obliquely along the long axis of the country. This mountain mass divides the country into two unequal parts—the larger of which lies to the east. The main range extends from South Kedah in the north to North Johore in the south and contains five peaks of over 7,000 feet in height, and between the main range and the flat coastal areas there are extensive foothills.

The limestones of the carboniferous series form prominent hills in several parts of the country and one of the most striking and picturesque features of Malaya are the isolated hills of perpendicular masses of crystalline limestone. They occur frequently in the eastern portion of the country and remind one of the limestone masses which are characteristic of the landscape paintings and etchings of Chinese art. Limestone hills also occur to the westward of the mountain ranges in Perak, Selangor and Malacca and they are often riddled with caves and rock shelters. Evidence has been obtained to show that these shelters provided the places of abode for the prehistoric inhabitants of the peninsula.

A series of volcanic rocks, older than the granite, exist. These are found mainly in Pahang and are known as the Pahang Volcanic series. They also appear in parts of Negri Sembilan and Kelantan.

Recent deposits form the coastal alluvia, which consist of clays and peat in the west and sands or sandy gravels in the east. The greater part of the western coast line is clay or peat and is fringed by a belt of mangrove swamp of varying width. In the east, the seashore is sandy, the land behind being composed of a series of ridges of high ground consisting of parallel sandy beaches with swamps in between them. These alternating ridges of sand with low-lying swamp alluvium between remind one somewhat of the frontal land formation in British Guiana, but in this case little of the deposit of alluvium has been sea-borne.

Soil types agree closely with geological formations and have been produced by the rapid weathering of the rocks under the influence of high rainfall and temperatures. Rapid changes from one soil to another are to be seen in some parts of the country and not infrequently a regular patchwork of differing soils occurs within a comparatively small compass.

The *granite* soils are the least mature and contain equal portions of sand and clay. They are associated with the central mountain range and, except for areas in the Cameron Highlands plateau, they occur generally on slopes which are too steep for satisfactory agricultural development. They are characterized by being easily drained. Rainfall percolates rapidly through these soils if they are undisturbed, but the hill slopes are very liable to erosion if they are heavily cultivated and to landslides if there are any large accumulations of water in pockets or in drains artificially made.

The *quartzite* soils in the hills contain a low proportion of coarse sand and are therefore liable to close packing. In the valleys they are very variable and are not infrequently highly leached. Quartzite soils are of low fertility, especially when they have been under cultivation for a few years. Nevertheless they constitute the bulk of the land which has been developed for agriculture.

The *Raub* series soils in the hills are characterized by their deep red colour and by the occurrence of laterite at depths of $1\frac{1}{2}$ to $2\frac{1}{2}$ feet, whilst at lower levels they are usually found on recent inland alluvia overlying limestone. They occur mainly on the east side of the peninsula but in Malacca and Negri Sembilan these soils have been used for agriculture.

The *Pahang volcanic* soils, found mainly in Pahang and Kelantan, are formed from basalt. They are generally rich in nutrients and possess excellent physical properties. They are of relatively infrequent occurrence.

The *coastal alluvia* consist on the western side of the peninsula of clays and peats or a mixture of clay and peat. The clays are rich, but are heavy and difficult to drain whilst the peats drain readily and shrink very considerably on being drained. In fact, large areas of old rubber planted on peat now stand with roots exposed—the land level having fallen up to two feet or even more since the original planting was done. A stilt-root appearance results and is characteristic of those areas when root exposure has resulted from the soil's contraction. Some of the worst areas present a picture not very different from mangrove growth and steps are now being taken to replant the worst of these areas. Coconuts also planted on these peaty soils have been lost in Johore by sea-water inundations consequent upon land shrinkage after cultivation and drainage. The extensive

plains to the east consist of sands and gravels which have been deposited from the river floods which are not of infrequent occurrence.

Agricultural development has taken place mainly in the foothills, the coastal areas of the west and east coasts and the plains of Kedah and Johore. The foothill country is much broken and this area is devoted to permanent crops, with a certain amount of padi cultivation in the valleys.

The basic factor controlling Malayan agriculture is the general poverty of the soil, especially in the foothills and in the south. The coastal alluvial flats, the plains of Kelantan, and the soils derived from the rocks of the Pahang volcanic series are exceptions. At first sight this seems to be contradicted by the luxuriance of the vegetation but once the forest has been cleared and the land brought into cultivation fertility rapidly falls. Practically the whole peninsula was at one time covered with forest and the agricultural development which has taken place has been won from the forest. Mangrove swamps in the west have been cleared and drained for rubber, coconuts and oil palms. Swamp jungle has been cleared for the creation of padi-growing areas and the inland heavily-timbered hill lands have been cleared for the growing of rubber, oil palms and other crops. In many places this forest was very heavy. The Malayan village settlements or " kampongs ", built up on lands higher than the levels of the padi fields and now shaded with fruit trees and other planted tree crops, have all been developed from lands which were at one time under forest.

Cultivations of rapidly growing crops or annual food crops soon demonstrate the rapidity with which fertility falls when the land has been cleared of the forest and brought under cultivation. After the first year or two the growth is very poor and where " kampong " lands have been planted with rubber poor growth has resulted. Low fertility is accounted for by the absence of any extensive dry season except in the east and in consequence there is insufficient time for the accumulation of readily available nutrients in the soils.

Malaya is a country of heavy rainfall, high humidity and uniform temperatures. The temperature range is only about 10° on the coast and 15° inland, but in the hills the temperature range may be up to 30°. There are three distinct regions of rainfall, each with its characteristic variation. The inland region embraces the whole of Malaya except a narrow coastal belt to the west and the east coast region. It is characterized by two wet and two dry seasons annually—the wet seasons being from September to December and from March to May. The two driest months are February and July. The west coast region has one wet and one dry season during the year following

the south-west monsoon, with maximum precipitation in August and the minimum rainfall in January; whilst the east coast region follows the north-east monsoon which extends from October to March with the heaviest rainfalls normally experienced in December. The driest month in the east is July. The annual rainfall along the east coast is heavy, being about 120 inches with a lengthy dry period from March to October during which relatively little rain falls.

The average annual rainfall varies from 85 to 100 inches in the inland region, but in the foothills averages in excess of 150 inches are experienced. The actual falls of rain during the south-west monsoon period are relatively light and usually occur during the nights. There are few days without sunshine and it is characteristic of much of Malaya that there are very few days on which agricultural operations cannot be carried on or when tapping of rubber is seriously interrupted. Frequent and light rains with abundant sunshine and a uniform temperature are the chief features of the Malayan climate, except in the eastern regions where heavy downpours during the north-east monsoon period are not infrequent and a long dry period occurs between monsoons.

Climatic conditions are more favourable to tree crops and unless these tree crops form a good canopy, the land requires to be heavily mulched or protected by shade trees or ground cover. If tree crops are not grown, an adequate provision of organic manures is essential to success and if animal husbandry with the object of providing farmyard manure cannot be introduced more extensively into the methods used for the production of foodstuffs other than rice and certain other crops, greater attention will have to be given to the preparation and use of composts.

The general low fertility of the majority of Malayan soils has not yet been sufficiently realized and the increased and continued prosperity of the population will depend upon attention being given to this problem.

Political Divisions and Agricultural Industries.

Malaya is divided into three political groups as follows:—

(1) The colony of the Straits Settlements, consisting of Singapore Island and the settlements of Malacca, Province Wellesley, and Penang. It also includes the outlying territories of Labuan, Cocos Island and Christmas Island.

(2) The Federated Malay States of Perak (including the Dindings) Selangor, Negri Sembilan, and Pahang.

(3) The Unfederated Malay States (each under its Malay Ruler) of Johore, Kedah, Kelantan, Trengganu, Perlis and Brunei.

The total population of the peninsula is now 4½ millions of which 1¼ millions are engaged in agriculture. Of these 400,000 are working on estates and about double that number of adults occupy small-holdings. The most densely populated rural area is to be found on the plain of Kelantan in the east—which significantly has a well-marked and lengthy dry period each year.

The main crops arranged in order of acreage are as follows:—rubber, rice, coconuts, oil palms, pineapples, fruits, arecanuts, tapioca, bananas, coffee, vegetables, derris, tea, gambier and tobacco. Plantation crops (rubber, coconuts, oil palms and tea) cover over 4 million acres whilst the area under padi is 739,000 acres and only 54,000 acres are devoted to food crops other than rice.

Rice was grown by the Malays from early times but it is only within recent years that attention has been directed to the extension of the area devoted to this crop and to the improvement of the types grown and the cultural methods employed. The cultivation of coconuts along the western coastal areas is also an old-established industry, and gambier has been grown as an export crop for well over a hundred years. The earlier planting enterprise interested itself in the growing of pepper and gambier, especially in Singapore and Penang, and subsequent interest was shown in nutmegs and cloves in Penang and the adjoining mainland. Tapioca also was established as an important export crop. Sugar cultivation was started in Penang and Province Wellesley and flourished for a period but with the decline in profits from sugar, coconuts were substituted and the growing of Liberian coffee was developed in Perak and Selangor. Pineapples for canning purposes were grown from about 1888 in Singapore and Penang but in the latter settlement the factories soon disappeared and in Singapore the industry was taken over and developed by Chinese. It has been considerably extended and is at present an important industry in the State of Johore.

Rubber-planting on a commercial scale started when coffee began to decline around 1890, and rubber is now the chief agricultural crop of the country. In fact the whole agriculture of the country is dominated by rubber with its total of 3¼ million acres out of a total cultivated area in all crops of 5 million acres. Slightly over 2 million acres of rubber are estate-owned and 1¼ million acres in holdings of less than 100 acres each. Half the estate acreage is located within the Federated Malay States, and the largest areas of rubber in small-holdings are in Johore and Perak. Two-thirds of the pineapples and three-quarters of the arecanuts are now grown in Johore, whereas one-half of the land devoted to rice cultivation is to be found in the Unfederated States of Kedah on the west and Kelantan on the

east. Oil-palms are a comparatively recently introduced plantation industry—half the acreage being grown in Johore and the other half in Perak and Selangor. Johore has the largest acreage of any state in coconuts but its acreage devoted to rice is still comparatively small.

Plant disease accounted for the decline of some of the crops which have featured in Malayan agricultural history, but it is probable that insufficient attention to soil fertility may also have accounted for some of the difficulties experienced. There is no doubt that many of the earlier agricultural enterprises were ruined by poor systems of husbandry, which did not take account of the fact that most soils in the wet tropics are of low fertility unless their content of organic matter is adequately maintained. By reason of high temperatures, the destruction of organic matter is rapid under moist conditions in the tropics, whilst minerals and nitrogen are rapidly leached if the land is not covered by a cover of vegetation. Losses are less in the forest or in heavily shaded and densely planted kampong holdings as the carpet of fallen leaves decomposes more slowly. There are, however, thousands of acres of land to be seen to-day in Singapore and south Johore which have been ruined by wasteful methods of exploitation.

Fortunately for Malaya, rubber thrives like a weed and grows reasonably satisfactorily on even the poorest of soils. It provides shade for the soil and once a year a good carpet of fallen leaves. Response to phosphatic manures has been satisfactory in several areas and the prospects of areas showing poor growth have in recent years been completely changed by the use of applications of rock phosphates. The prosperity of Malaya has in fact been built up on rubber and with the development of that industry other estate crops including spices, tapioca, sugar and coffee have disappeared. Small-holders also have transferred their attention to rubber. Many of the " kampong " lands have been planted in that crop and quite a number of areas, even padi fields, which should never have been planted, are to be seen with rubber trees struggling to make growth.

Malays far outnumber other races as small-holders and practically the whole of the 739,000 acres under padi is cultivated by Malays. Small-holdings are of two types—those consisting wholly of high land (averaging 5 acres in extent) planted with fruit trees, coconuts or arecanuts, and those consisting partly of paddy lands (3 acres) with smaller areas (2-3 acres) of high lands. In the coastal and riverine districts the family income is frequently supplemented by fishing.

Chinese small-holders cultivate rubber, pineapples, fruit trees, tapioca and vegetables. The two latter crops are always associated with pig-keeping—the manure being used freely for market-gardening enterprises.

Soil Conservation.

In the rush to cultivate rubber little attention was paid to soil conservation either by estates or by small-holders, especially in the inland areas, and Malaya was for many years behind other rubber-growing countries in the adoption of anti-erosion measures and in the use of cover crops. The position has, however, greatly changed in the past ten years. Determined efforts have been made to establish cover crops and many areas of newly planted, or recently replanted areas of rubber are now to be seen, especially in hilly areas, where anti-erosion measures have been adopted. Nevertheless, much more still remains to be done in Malaya if the position is to be regarded as wholly satisfactory. The acreage under rubber where bad root exposure is to be seen is relatively small but this is probably due to the rainfall in Malaya being evenly distributed and gentle in its fall. There is, however, too great an area of bare land under old rubber in Malaya, and greater efforts in the establishment of cover crops are still desirable. Sumatra experienced in many places difficulty in the establishment of cover crops until the use of phosphatic manures became general and it was there found that with perseverance and with more frequent applications of phosphates cover crops could be established.

It is now recognised that in the wet areas of the tropics where there are no well-marked dry seasons it is essential, if soil fertility is to be maintained, for the land to be kept under a cover of vegetation. Luxuriant virgin forest growth is not necessarily an index of the suitability of land for agricultural occupation. It has been found in many parts of the wet tropics that land when cleared of its forest cover rapidly becomes leached and loses its fertility. This is particularly the case where soils are acid, as is the case in Malaya where their pH values range from 4.5 to 5.4. Soils under such conditions cannot be maintained in cultivation, except for limited periods, unless heavy dressings of manure are applied or they are planted with tree crops which provide satisfactory shade to the soil and an abundance of leaf fall. Even then it has been found in the West Indies and in certain parts of Africa that certain tree crops will only be reasonably productive for long periods if they are heavily mulched or interplanted with cover crops. In coffee, lime and cacao cultivations, the value of the use of heavy mulchings with grass and other vegetable refuse has been proved in several areas and the importance of the use of cover crops has been fully demonstrated in the case of several crops in the East and elsewhere.

Reference has already been made to the need for further attention being given to the establishment of cover crops under

rubber in Malaya and equally it is necessary to test the value of mulching in coffee and fruit cultivations, to encourage the uses of composts and to develop the introduction of animal husbandry in connexion with the small-holders' agricultural undertakings. Green-manuring is commonly practised in Java but in Malaya the results have not been satisfactory, whilst in regard to cover crops it is not necessary to restrict the choice to leguminous crops as an example was seen of a coffee plantation in Java having been completely rejuvenated by the establishment of a close carpet of soft weed growth which was lopped at periodic intervals and the loppings mulched round the coffee. Within a period of less than five years I was told the coffee had been rescued from a derelict condition under a system of clean weeding to being amongst the best growths of coffee in the district. It certainly was a striking picture at the time of my visit, the soil was fertile and being maintained in good condition with no losses from erosion and the crops were uniformly good.

The importance of attention to the maintenance of soil fertility cannot be overstressed in the wet tropics and as far as Malayan agriculture is concerned it is evident that excluding padi cultivation where a different set of biological factors prevails, the major problem before the Department of Agriculture to-day is the solution of the problems associated with the utilization to the greatest benefit of the kampong high lands.

Rubber.

Rubber, as has been previously stated, is the chief agricultural crop of the country. The rubber industry of the East owes its origin to the supply of seed which was obtained by Sir (then Mr.) Henry Wickham from Brazil in 1875 and from the seedlings brought from the same country by Mr. Cross in 1876. The seedlings from Wickham's supply of seed were raised at the Royal Botanic Gardens, Kew, and were despatched to Botanic Gardens at Calcutta, India, Peradeniya, Ceylon, and Singapore, Straits Settlements. Those sent to Calcutta did not thrive, but of the consignments to Ceylon and the Straits, plants were raised to maturity at Peradeniya and Henaratgoda in Ceylon and at Singapore and Kuala Kangsar in Malaya. The progeny of these trees cover the millions of acres under rubber in the East to-day. It is from them that the important plantation rubber industry has been established. The history of the developments which have taken place it is unnecessary to detail at this stage. Everything had to be learned. The best methods of opening up forest-clad areas with rubber plantations had to be learned, methods of tapping and factory production evolved and methods of plant sanitation perfected. Labour organization had to be established and malaria controlled. The year 1910, owing to the rapid advance of the motor industry, saw an

acute shortage of rubber supplies and this stimulated planting to a remarkable extent and ultimately led to the interest of small-holders in rubber as a money crop. Production eventually outstripped consumption, and Regulation schemes had to be devised in order to prevent the ultimate collapse of the industry with distress to all concerned.

The total area under rubber in Malaya at the end of 1937 was 3,302,170 acres, of which 2,026,348 acres were planted on estates of 100 acres or over and 1,275,822 acres in small-holdings (i.e., under 100 acres each). Production was regulated in accordance with the terms of the International Rubber Regulation Agreement. Malaya's quota was 589,000 tons and the releases for export varied with the percentages determined by the International Regulation Committee. Malaya's shipments of crude rubber amounted in 1937 to a total of 469,960 tons out of a total world production of 1,135,107 tons. Local consumption by manufacturers of rubber goods in Malaya amounted in 1937 to 576 tons.

A considerable amount of valuable research work was done in the early period of the rubber industry in Malaya by the scientific officers of the Department of Agriculture and by the research organization maintained by the Rubber Growers' Association. In 1925, it was decided that the industry had made such development as to warrant the creation of the Rubber Research Institute of Malaya to take over the research and technical advisory work on rubber production. This Institute is financed by the industry itself by means of a cess on rubber exports and from 1927, when it had collected the staff, the Institute worked in temporary quarters until its new premises were completed for occupation in May, 1937.

The allocation of its work is, in general terms, now defined as follows:—

Soils division.—All problems relating to the preparation of land for planting, and to the treatment and maintenance of the soil thereafter. Ecological problems.

Botanical division.—All problems relating to the growth and treatment of the rubber plant in health. Ecological problems.

Pathological division.—All problems relating to the diseases and pests of the rubber plant and of other plants in association with it. Microbiological problems relating to rubber soils, latex and raw rubber.

Chemical division.—All problems relating to latex, from the time it leaves the tree to the raw rubber made from it, up to the time of export from Malaya.

The Small-holders' Advisory Service.—To afford advice to all small-holders on all technical aspects of rubber production.

The administration of the work of the Institute is entrusted to a Director and its general governance is now carried on by a Board of nine members, in addition to the Director as Chairman, and a Permanent Committee of four as laid down by Enactments designed to give effect to the recommendations made by the Commission of Enquiry which was presided over by Professor F. L. Engledow, C.M.G., in 1933.

I was afforded several opportunities by the Director of the Institute (Mr. H. J. Page, M.B.E.) and the staff of examining in detail the work which was now being performed for the industry. Various problems were discussed in detail, visits paid to the Central Experiment Station at Sungei Buloh, the Institute's laboratories in Kuala Lumpur and to numerous estates where experimental replantings were in process. I was also afforded an opportunity of seeing the Small-holders' Advisory Service at work in the field and through the courtesy of Messrs. Dunlops Limited, I was enabled to visit, in company with their scientific adviser, Dr. Hains, and the General Manager in Malacca some of their estates in Johore and also Ladang Geddes in Negri Sembilan.

There is no doubt that the rubber industry in Malaya is fully alive to the importance of scientific research and that the Institute is performing work of the highest quality and value for that industry. It may be said, without fear of contradiction, that the Malayan rubber industry is now being served, as far as technical guidance is concerned, better than any other agricultural industry in the Colonial Empire and I was particularly pleased to note that the emphasis which the Engledow Commission laid on the importance of any policy of applied research being determined by economic considerations is fully recognised by the Board of the Institute, its Director and staff. Problems of purely transient interest are not, as the Director states in his Report for 1937, allowed to figure in the work of the Institute.

It is unnecessary to attempt any detailed picture of the Malayan rubber industry of to-day or to give an account of the information which has been made available to planting interests as the result of research work and investigations carried out by estate companies, officers of the Rubber Growers' Association, the Department of Agriculture or, in more recent years, by officers of the Institute. These are to be found in the reports and bulletins which have been issued from time to time and to summarize them even would run into many pages. I was particularly interested, however, in the work that was being done at the time of my visit on the use of root promoting substances and in the results which had been secured. My main concern however was to ascertain the present position in regard to (1) soil treatment, (2) rubber manuring, (3) replanting, (4) the development of improved high-yielding planting material,

and (5) the services provided for small-holders. Subsequent visits to Java and Sumatra enabled me to make comparisons with the position of the rubber industries in those islands of the Netherland East Indies. My general conclusions may be summarized as follows:—

Soil Treatment.

The soils of Malaya, as has been mentioned previously in this Report, are basically poor and once the forest litter has been destroyed after the clearing and burning of the jungle, there is a gradual fall in fertility and also a change in soil structure. On much of the land which was opened in the hill lands there was little attempt made, in former years, to check the effects of erosion and clean weeding was the order of the day. Erosion has however not been so bad as in Ceylon, probably by reason of the greater regularity and more gentle nature of the rainfall but it is clear that the earlier pioneers in Malaya, as was the case also in Ceylon, did not give as much thought to soil conservation as did those who opened up lands in Java and Sumatra. The position has fortunately now changed and all recognise the importance of soil conservation, even though it must be stated that more can yet be done in practice. In all replantings or in the opening of new areas care is now taken to provide adequate precautions to conserve the soil and its fertility, but in large sections of the older rubber it is clear that more can be done. The provision of lines of stones and bunds along the contours is not to be compared in extent with the work of a similar character which was done in Ceylon and it is only in the latest plantings that contour terracing along lines similar to those so commonly seen in parts of Java have been adopted. Contour drains have been provided and silt pitting has been undertaken but further thought should be given as to the additional measures against erosion which would be suited to the conditions of the country. It may be held by some that a condition of soil stability has now been reached in soils carrying old rubber and that erosion is not as serious as was the case when the rubber was young. This may be the case, but it cannot be overlooked that this land will at some future date require to be replanted, and that it is essential to future security that the soils should be improved before the replanting is due to be carried out.

Much thought has been given to this aspect of the question and the rejuvenation of old rubber lands is recognized as an issue to which a solution must be found. The line of work which has so far been done embraces the manuring of the old rubber and the use of covers, both indigenous and introduced, to improve soil conditions generally. So-called forestry methods for rubber—whereby indigenous plants are permitted to grow as covers on estates—has its advocates and equally its strong opponents. As

is usual in controversies of this kind, there is support for both sides. Uncontrolled growth of natural bush covers has been found to affect the foliage of rubber as the result of root competition and there is no doubt that supervision of tapping is more difficult when forestry methods are adopted. On the other hand, the use of natural cover is preferable from the soil's point of view to no cover at all. It seemed to me that more frequent lopping of the " natural " covers might be advantageous and that such a system might lead to a greater accumulation of " forest litter " on the surface of the soil, which is the main objective to be aimed at. It is fairly generally recognized, however, that the use of indigenous covers has a limited value and that a normal healthy and vigorous condition in the rubber trees can only be achieved, on deteriorated soils, by the use of manures when natural covers are used. I did, however, see in Java a coffee estate which had deteriorated almost to abandonment completely rejuvenated by the use of selected indigenous covers which were lopped every three months and the loppings mulched around the coffee trees. This leads me to suggest that further experimental work on these lines should be made in Malaya with rubber.

Leguminous cover plants have been tried widely in old rubber but generally speaking very little success has been obtained by estates in their attempts to grow leguminous cover (whether bush or creepers) under shade, owing partly to the shade effect and partly to root competition. The position in Malaya is, in fact, in marked contrast in this respect with the position in Java, Sumatra or even Ceylon. Difficulties were experienced in Ceylon in the establishment of covers in old rubber but with perseverance these difficulties were overcome, even though the persistence of the covers established was in some cases limited to a few years. In Java, there is no real difficulty in regard to persistence of cover plants under old rubber, but the soils there are of recent origin, of considerable depth and of high fertility. In Sumatra, difficulties have been experienced both in the establishment and maintenance of covers, but with perseverance these difficulties have been overcome. When covers show signs of deterioration in Sumatra applications of phosphatic manures are given to them and the response is marked. One large estate group in Sumatra informed me that it was now their practice to think in terms of manuring the cover plants rather than in terms of manuring rubber, as they were satisfied with the results being obtained and felt that it was to the estates' interests—taking the long view—to maintain soil fertility and soil structure rather than to look for increases in rubber yields for a few years. It is possible that the importance of covers in old rubber is being overstressed on some estates in Java, particularly when one considers the

general high fertility of Java soils, and it is also possible that experimental data is not conclusive as to their immediate value in parts of Sumatra, but the contrast between the general attitude of rubber interests and research workers in the Netherland Indies with those in Malaya in regard to covers under old rubber cannot pass without comment.

The conclusion I reached was that much more work on this aspect of rubber cultivation was still required in Malaya, that the long and not the short view should dominate the considerations given to the subject. Measurements of improvements in soil structure and fertility are equally as important as measurements of rubber yields.

In the rubber industry, the long view is essential if continuity is to be assured, especially as it is now recognized that replacements of stands at regular intervals of say 25 years by improved planting material may become a normal feature in the system of cultivation. To the observer, the absence of soil covers under mature rubber is one of the marked characteristics in Malaya and under such a system there must be some misgivings as to the future if areas now under rubber are not to be abandoned in favour of opening up new lands. One area was seen in Province Wellesley where covers had been established under old rubber. They were growing luxuriantly in spite of heavy shade and the soil condition under them was excellent. It is true that the soil was basically a good one and therefore their establishment had been comparatively easy. In the case of the poorer soils, the position is very different, but whilst the manuring and inoculation of covers is the subject of current experiments by the Rubber Research Institute I would advocate a greater measure of work in connexion with this problem. It is possible that applications of phosphates may be necessary for one or two years before the attempt is made to establish covers and that the system of raising cover crops in nursery beds made of soil and compost and including pieces of broken coconut husk and then transplanting rooted plants, as was successfully done in Ceylon, rather than the sowing of seed, may offer possibilities.

MANURING.

Much valuable work has been done in Malaya both by the Rubber Research Institute and by estate groups. I was able to inspect several of the areas under experiment and to discuss with the officers concerned the results which have been achieved. The great importance which was formerly attached to nitrogen has been found to have been mistaken. Old rubber in Malaya apparently requires phosphates and some nitrogen and it is general to advise fertilizer mixtures including nitrogen, phosphoric acid and potash. The value of a "complete" manure is generally accepted but on the clay soils in the coastal

areas the need for the inclusion of potash might be queried. The interaction between the plants requirements for phosphates and potash has been established in the case of a number of crops, and the inclusion of potash in fertilizer mixtures for rubber, is I understand, rather in the nature of an insurance against the production of an unbalanced position than in accordance with the dictates of actual requirements. In Java, increased yields have been obtained from phosphates and to a lesser extent from potash, while in Sumatra the importance of phosphates is now recognized and on some soils applications of nitrogen are beneficial.

The effects of manuring in old rubber—even when "complete" manures are employed—are not seen rapidly except in the density of the leaf canopy and in some cases it has been found that effects on yields of rubber are not noticeable until three years after the applications have been made. The manuring of rubber which is more than 25 years of age is of doubtful value and it is deemed to be uneconomic to apply manurial applications to fields where the general vigour of the trees is poor and the yields low.

I was able to see the effects of phosphates in the case of young rubber in Malaya. The plantations have to be seen before it can be fully realized what marked differences do occur when applications of phosphates are made. It has, in fact, been demonstrated that in some instances the applications of phosphates are beneficial even when land is brought into cultivation from good jungle. The effects of applications of phosphates are almost immediate in young rubber, especially if they have been applied after a light forking. Furthermore, it has been proved that only relatively small quantities per acre are needed and that rock phosphates are as equally effective as the more costly forms of phosphatic manures. Young rubber manured with phosphates is ready for budding at a much earlier age than when no such applications are made. Such budded rubber manured with phosphates is large enough for tapping to commence at least one year before it would otherwise have been.

In replanted areas it has been found that an adequate phosphate supply is of main importance to the young seedlings, that small dressings at frequent intervals, as has also been found to be the case in Sumatra, are preferable to larger applications at longer intervals of time and that during the early months of growth the use of water-soluble phosphates is advantageous.

Replanting.

During 1936, a total of 25,188 acres were replanted in Malaya and 28,519 acres were sanctioned for replanting in 1937. The percentage of acreage replanted or planned for replanting in

Malaya is considerably less than is the case in the Netherland East Indies and I was informed of no areas in Malaya, which were still yielding satisfactorily, which were being replaced by improved planting material with the object of being prepared for more intense economic competition at some future date. I saw one case in Java, where rubber yielding over 500 lb. per acre was being replaced, because it was anticipated that with improved planting material yields of fully 800 lb. per acre would be secured and that by so doing the competitive position of the estate would be improved should the world price of rubber fall again to low levels. My general conclusion on the information gathered in Malaya was that too conservative a policy was being adopted in regard to replanting and that consideration was being centred perhaps too largely on the prospects of securing releases of new areas for planting.

The standard procedure in regard to replanting is as follows:—

(1) Slaughter tapping is usual for a short period before the rubber is cut out.

(2) Diseased areas are isolated before felling by root inspection in trenches. Much progress has been made in recent years in the knowledge of root diseases of rubber and the methods which should be adopted for their satisfactory treatment. The actual food supplies necessary for the fungi responsible are not however yet fully known and in this regard the recent work of Leach in Nyasaland in regard to Armillaria was discussed with the staff at the Institute.

(3) Trees are removed (*a*) by felling and then digging out the tap roots, or (*b*) by " jacking-out " the tree and tap root in one operation. The timber of the old trees is either removed from the area to be used as firewood or else is piled between the new planting rows, a minimum amount of burning being done to destroy twigs and light branches. On hilly land the trees or logs from them are placed along contours and used in this way for building up the front edges of contour terraces.

(4) Diseased areas are dug over either before or after felling and as much diseased root material removed as possible.

(5) The land is lined for replanting, it being customary to plant ordinary seed at stake, four or five to a hole, thinning to two at the end of six months. The planting density is 200 to the acre so as to permit a wide margin for subsequent thinning: between the rows of plants leguminous creeping covers are recommended. To establish them satisfactorily it is frequently necessary to use phosphatic manures and the use of inoculated seed is often advantageous. *Pueraria javanica, Centrosema pubescens* and *Calopogonium*

mucunoides are the creeping covers commonly used and they are generally mixed. *Desmodium ovalifolium* is also another cover which is showing promise. Bush legumes such as *Tephrosia candida, Tephrosia Vogelii* or *Crotalaria anagrioides* it has been found have the effect of seriously retarding the growth of young rubber, by reason of their shading effects, and in consequence of the root systems of the legumes developing into the planting-holes. A similar retarding effect may result from creeping ground covers if their growth is heavy and luxuriant and I saw one experiment where " weeding strips " along the lines of the young rubber were being isolated by " vertical slicing " into the soil at regular intervals of time in order to sever the cover crop roots which enter the area where the rubber plant roots were developing. It is probable that this system will have beneficial results.

I would suggest that a trial be made of lopping the cover crop growth at intervals and the use of the loppings as a mulch on the " weeding strips." It is possible that retardation of the growth of the young rubber may be due to root competition but it cannot be accepted that the maintenance of areas of bare soil is sound in any cultivation in the wet tropics. Mulching has been proved of value in cultivations of a number of other tropical crops in other wet areas and it has not received the attention it deserves in Malaya. Creeping ground covers also seem to last better if they are enabled to scramble over some low bush growth (even young rubber seedlings serve a useful purpose in older plantings) and it is well known that many of them reseed themselves only when they are enabled, so to say, to lift themselves in the air.

(6) The manuring of young rubber on replanted areas is essential and a complete inorganic fertilizer is at present recommended.

(7) Careful watch is kept on disease; root inspection at frequent intervals is now being generally adopted. Giant snails also are troublesome at times but it has been found that baits consisting of Meta fuel mixed with bran has proved effective as a control.

Planting of New Areas.

The planting of rubber on reserve lands was permitted by the International Rubber Regulation Agreement for experimental purposes to the extent of one-quarter of one per cent. of the existing planted acreage and out of the 8,177 acres permitted for Malaya a total of 5,428 acres had been planted at the end of 1937. Plans for these experiments have been prepared in consultation with and with the approval of the Rubber Research

Institute. They include trials in different areas, under different soil conditions and on lands which had been under jungle or under different systems of cropping with crops other than rubber. The trials include tests of planting material, cultivation methods, soil treatment and manurial applications. They have all been carefully planned by the Institute and the work has been excellently performed by the estates concerned. The results of these trials will without doubt be of great value to the industry in due course and they do mark an excellent piece of co-operative work between the practical planter and a scientific institution. This performance of experimental work in collaboration with estates has been a feature of the progress made in several agricultural industries in the Netherland East Indies and is at long last becoming to be accepted as feasible in the British tropical possessions. Progress has already been made in regard to the sugar industry in the West Indies and it was very pleasing to see the work which was being done in Malaya by the officers of the Rubber Research Institute in full co-operation with estate managers and agents. Much extra work has been thrown on the staff of the Institute in connection with the experimental plantings, but this has been accepted enthusiastically and the collaboration received from estate interests has been most encouraging. I shall always remember the marked contrasts which were to be seen between the growth of young rubber on manured plots as compared with slow growth on unmanured plots on poor land belonging to United Patani Estate which had been in tapioca, gambier and pineapples and had been allowed to become covered with lalang grass before it was taken up again under this scheme for experimental planting.

Development of improved high-yielding Planting Material.

Most of the earlier rubber in the East was established from unselected seed collected on the ground from an ordinary seedling plantation. This gave place later to the use of selected seed collected from recorded high-yielding trees and general experience showed that such progeny gave appreciably higher yields than the plantations made from the ordinary unselected seedlings. Then came the period which gave rise to the development of budgrafting. From 1918 to 1924, large numbers of clones were established by research stations and private estates in the Netherland East Indies and Malaya. Of the many hundreds of high-yielding trees which were selected from the rubber plantations and from which clones were developed, only a small number have proved to be of outstanding value and worthy of recommendation for general planting. The list of clones recommended by the Rubber Research Institute in Malaya for use on a commercial scale contains about 10 numbers which were established before 1925. These have been tapped for

periods of not less than nine years and have also been tapped on renewed bark and on further buddings taken from them in order to check the claim that the behaviour of the original buddings will be repeated. These are known as proved clones and are regarded as the safest improved planting material available at the present time. They vary in their suitability for different soil conditions and environment and a considerable amount of information is now available about their individual idiosyncrasies. The results from budgraftings from proved clones show beyond the possibility of doubt that yields greatly in excess of those obtainable from unselected seedling material are being secured in estate practice and that the anticipated difficulties in regard to bark renewal, continuance of yielding capacity, general adaptability and disease susceptibility, have not been experienced to any marked extent. For new plantings, the use of budded material is now generally recommended and it is expected that in time additional proved clones of possible higher yielding capacity will be added to the lists. These lists of recommended clones vary in Malaya, Java and Sumatra as some of the clones which have been developed are somewhat more adapted to the environmental conditions and requirements of the areas from where they originated. Sumatra clones, for example, must be wind resistant and in other areas there are preferences for those which are early maturing.

It is now accepted that the rubber plantations have been searched so thoroughly that it is unlikely that new high yielding material for selection will be found in them, and further advances are likely to be made only in regard to the newer clones at present under preliminary test or from legitimate seedlings produced by the plant breeders. There is, for example, one clone in Sumatra, No. Avros 352 which is giving astonishing yields in the early years.

This development of clones of budded material is naturally not the end of the picture. It was held, particularly in the Netherland East Indies, that the period of budgrafting might possibly, as has been the case with other tropical crops in Java, be only a transitional phase. Isolated seed gardens of mixed clones were established in Java and a similar procedure was adopted in Malaya. In many cases the numbers of clones used was considerable and as experience has been gained the number of these clones in the seed gardens has been reduced. It has been found that a good bud-parent is not necessarily a good seed-parent and the true value of illegitimate clonal seed can only be determined by the performances of the progeny raised.

Heusser at the A.V.R.O.S. Station in Sumatra was the first to make a genetical study of rubber and he showed that certain families of seedlings were capable of yields that compared

favourably with those of the best proved clones in that Station's collection. Subsequent work in Java and Malaya has confirmed Hausser's work, but it is obvious that seedling families will require just as long a period for proving as is taken for proving the buddings of a clone. It has, however, been found in Sumatra that legitimate seedlings resulting from the crossing of carefully selected high-yielding parents give yields which are more than double those of unselected seedlings and that the best family group gives yields comparable with buddings of first-class clones. Clones which appear to give high-yielding seedlings irrespective of the source of the pollen from the male parent are Avros. 157, Avros. 163, Tjirandji I and A.44. In Malaya the cross B.84 × A.44 is giving the best yields whilst in Java seed from Tjirandji I × Tjirandji 16 is being produced on a commercial scale. From the best individuals of the most promising families obtained by hand pollination, new clones have been made and are under experimental test. Some of these clones have given very promising results and a small number appear to be superior to the majority of the older proved clones at present in commercial use. The work in Malaya was delayed for a period by the retrenchment of the Geneticist in the period of the slump and at present the Malayan authorities are prepared to recommend the planting on an experimental basis of only 5 per cent. of replanted areas with clonal seedlings, whilst the Sumatra Proefstation is suggesting a percentage of up to 20 per cent.

The workers at the West Java Proefstation are concentrating on controlled crosses and estates in Java are establishing increasing numbers of seed gardens in which a limited number of clones are being used. One large estate group is definitely strongly in favour of the use of improved seedling material and there seemed to be in the Netherland East Indies a decidedly wider interest in improved seedling material than there was in Malaya.

As Mr. Murray stated in his report to the Rubber Research Scheme in Ceylon in 1937, the position in regard to legitimate and illegitimate clonal seedlings is much as it was about eight years ago with buddings and it is to be hoped that Malaya will see that the staff working on the breeding of rubber will be maintained at full strength.

Small-holders Advisory Service.

Small-holdings of rubber in Malaya are held to be those of less than 100 acres each. They constitute nearly 37 per cent. of the total area under rubber and produced in 1936 some 132,000 tons of rubber. A separate Small-holders Advisory Service has therefore been established by the Institute and it was decided in November, 1937, that the staff of 24 Asiatic Rubber

Instructors should be doubled, as suitably trained officers become available, within the next six years. These officers are selected from the students who have passed through the School of Agriculture at Serdang and subsequently given special training at the Rubber Research Institute and its Experiment Station. They work in the field under the general supervision of the Agricultural Officer for the district and are visited and their work inspected from time to time by the Small-holding Officer. This co-operation with the Department of Agriculture in regard to small-holdings works satisfactorily and it is to be hoped that it will be continued.

Efforts have been made to effect improvements in cultivation and tapping methods, but more particularly in the quality of the rubber produced. In the latter respect considerable and useful progress has been made and a number of improved small smoke-cabinets have been erected. In this connexion I would suggest that simple type plans be prepared and printed for distribution to holders when they are interested in the erection of smoke-cabinets and that attention be also given to the erection of suitable smoke-cabinets by those middlemen who purchase wet sheet from small-holders. It is frequently the case that the very small holder requires some cash at short notice, and he obtains this by a day's tapping of his rubber and the sale of his product wet to the nearest dealer. It is unlikely that this system will pass away and the middlemen dealers should be persuaded to provide the necessary equipment for the production of a good quality product. In fact, it might be considered whether such a condition might not be incorporated in his licence.

In some districts the small-holders do not feel encouraged to produce good smoked sheet because they do not get paid a sufficient premium to justify the additional expenditure of labour. In Pahang, a price-grading scheme has been working for two years and as a result the amount of unsmoked sheet produced has considerably diminished. The possibility of introducing similar price-grading schemes was under consideration at the time of my visit and I suggested, as experience elsewhere had shown with the produce of small-holders, that it was desirable to keep the number of grades down to the minimum consistent with the requirements of the market.

Much of the small-holders' rubber is still very dirty and if dirt could be eliminated there would be a very large step forward. Additional care and cleanliness is all that is required and it is obvious that the Rubber Research Institute is correct in placing this educational work in the forefront of their efforts on behalf of small-holders.

Progress is also being made with the control of mouldy rot and with the treatment of root diseases and termites.

EXTENSION WORK OF THE INSTITUTE.

The " extension " service of the Institute has also received the attention of the Director and he has suggested that this should include—

(1) the publication of the Journal and technical bulletins,

(2) the issue of a monthly *News Letter*,

(3) the giving of lectures at suitable centres,

(4) the holding of Conferences on topics of interest to rubber producers, and

(5) radio broadcasts.

The dissemination of the results of scientific research is always a matter of some difficulty and I commend the proposals which are now under consideration for the rubber industry of Malaya. If these proposals are adopted the industry will have taken an important step forward.

Rice.

The cultivation of padi (rice grain) is the main occupation of the Malay small-holders and since the Rice Cultivation Committee reported in 1931 considerable advances have been made. This Committee recommended the creation of a Drainage and Irrigation Department and that increased attention should be given by the Department of Agriculture to the problems of padi cultivation, including the provision of seed supplies of selected high-yielding strains.

The results of the work of the Drainage and Irrigation Department since its creation in 1932 have exceeded expectations and the Department of Agriculture, by the improvement of its organization for the padi-growing industry, has made it possible for material progress to be made in regard to cultivation methods and seed supplies of selected strains.

The production of rice in Malaya has shown steady progress, having risen from 264,000 tons in 1930-1 to 342,150 tons in 1935-6. During 1936-7 the production was, however, only 319,000 tons, despite the fact that the area under " wet " padi was a record, by reason of unfavourable weather conditions in some of the more important padi-growing districts. The areas under cultivation in that year totalled 694,000 acres under " wet " padi and 46,500 acres under " dry " padi. The areas grown for the season 1937-8 were expected to be in excess of the previous year's figures but the crop was thought to be slightly below average. During the time of my visit, I was, however, able to see some very good crops at various stages of growth. Crop prospects were reported generally to be good in Kelantan and the Federated Malay States, but below normal in the Krian district of Perak and parts of Kedah.

Increased production has resulted from the improvements which have been made in the drainage and irrigation facilities in the older areas, from the development of new areas and from increased attention being given to cultivation and seed supplies. Malaya, however, only produces about 40 per cent. of its rice requirements and continued efforts will be required if the country is to produce a greater proportion of its essential food supply. This should be possible if the measures which have been adopted since 1932 are continued without abatement.

The distribution of land cultivated in padi during 1936-7 is shown in the following table:—

	Wet Padi acres.	*Dry Padi acres.*	*Total acres.*
Straits Settlements			
Province Wellesley	32,500	300	32,800
Malacca	32,310	—	32,310
Penang	3,980	—	3,980
Federated Malay States			
Perak	93,110	1,980	95,090
Selangor	19,980	410	20,390
Negri Sembilan	34,370	20	34,390
Pahang	35,210	650	35,860
Unfederated Malay States			
Perlis	41,870	—	41,870
Kedah	246,310	1,710	248,020
Johore	8,030	880	8,910
Kelantan	113,110	29,800	142,910
Trengganu	32,770	10,740	43,510
	693,550	46,490	740,040

It will be observed that the largest areas are in the Unfederated States of Kedah and Kelantan—covering together more than half the the total area. The lowest proportion of the area under padi to the area of the land suitable for this crop is found in the State of Johore.

In Kedah, there are extensive stretches of padi lands near the coast but further inland in the same State the padi areas are intermingled with high land forest or plantings of rubber. The Kelantan plains are devoted extensively to padi and stretches extending over several square miles are to be seen in this State. In Trengganu, padi cultivation is scattered in small areas, as the land available is in excess of the population, whilst the areas in Pahang can be divided into the coastal plain which resembles Kelantan on a small scale, riverine lands liable to flood in the north-east monsoon season and inland valley lands. In Perak there are two major areas—the old-established Krian area in the north and the new and expanding area at Sungei Manik in the south. In Selangor there are extensive areas near the coast and, as in Negri Sembilan, padi is also grown in the small inland valleys. It is estimated that the area in the former State could

be more than doubled if suitable irrigation and drainage schemes were developed. In the old settlement of Malacca, the padi areas are relatively small with intervening high land planted with rubber or kampong cultures. Padi lands had been going out of cultivation in Malacca but with controlled drainage and irrigation this tendency has at last been checked. It is recorded, however, that 7,000 acres of padi land have gone out of cultivation in the Malacca River valley by reason of the gradual silting which took place from soil eroded from the rubber plantations established on the hill slopes. It would only have been a question of time before padi lands in Negri Sembilan would have suffered the same fate if the Drainage and Irrigation Department had not taken the matter in hand.

Visits were paid to a large number of padi-growing areas in the different States, to a number of the irrigation schemes and to nearly half the Padi Experiment Stations and test plots maintained by the Department of Agriculture. Visits were also paid to a number of privately-owned rice mills and to the Government rice mills in Perak. It is unnecessary to give in detail the notes which were made of the problems of the different areas; these were discussed with the officers concerned. A brief summary of the main features of padi growing in Malaya generally may, however, be of interest.

There seemed to be little doubt that padi-growing in Malaya is profitable and that the production of rice is possible at prices which compare with those of rice imported from the large rice-producing countries. The Malayan small-holder is definitely interested in the cultivation of his padi lands or *sawahs* and areas suitable for the crop are maintained in cultivation except in small areas where silting has taken place as the result of erosion from the hill lands opened in rubber or other cultures. In some areas padi-growing is the main occupation, but generally an important measure of money income is derived by padi-growers from other cultivations or occupations. For instance, rubber has provided the money income for the majority of small-holders in many areas. Kampong lands have been freely planted with rubber and in a few instances (involving, however, only relatively small areas) padi lands from which water could be diverted have been planted with this crop. There has however been but little abandonment of padi lands, as has been the case in parts of Ceylon, with the advance of rubber cultivation and the standard of cultivation has not markedly deteriorated. This is probably due to the fact that the padi lands of Malaya, except in certain parts of Malacca, are intrinsically of higher fertility than the padi lands of Ceylon and higher acreage yields are obtained from them.

In the Krian district, a feature of the padi area is the number of fish-ponds. These are managed skilfully and it is estimated that fish-drying brings in at least one-third of the total income

of the people, whilst a feature of the padi fields around Briah is the growing of mangoes on the bunds. This is a useful and profitable secondary industry, although some losses of trees are being experienced from the attacks of a longicorn beetle. It is possible that the growing of mangoes might be suitable for areas in Kedah and Kelantan, and I suggested that a trial should be made of this crop as a secondary culture in the padi-growing areas of Kedah before the visit to Brieh had shown that its possibilities had been realised in that area.

Experimental tests would be necessary, as the successful cultivation of mangoes depends so much on climatic conditions at the time when the trees flower. Showery weather when mangoes are in flower is fatal to crop setting and in areas where this is common yields are small. There are, however, some varieties which are more suited to wet conditions than others, but definite expressions of opinion can only be given after experimental tests have been made. There should be an ample market in Malaya for additional supplies of locally-grown mangoes at remunerative prices and as will be indicated later there is in fact a need for greater attention to be given to fruit culture generally. If trials, which are recommended, are made in Kedah and Kelantan, the better of the Indian mangoes should be selected and a wide range contemplated. Grafted or budded material should alone be used. Amongst the Indian mangoes, the Alphonso, Goa, Mulgoa, Bangalora and Pari might be mentioned, but advice from the Indian Imperial Agricultural Research Council might be sought before a final selection is made. Jamaica has found the Pari a suitable variety for its drier plains, whilst the Julie thrives satisfactorily in the wetter areas of the West Indies. The Pari has the disadvantage of growing into a large tree even when grafted, but the Julie is dwarf in habit and produces satisfactory and regular crops of good flavour even in districts where the rainfall is high. The experimental trials should be designed to determine if the mango can be introduced for cultivation as a secondary crop on the high lands in the padi-growing areas and whether it can be grown satisfactorily on the wider bunds between the fields.

Reverting again to the padi crop, there are definite indications throughout Malaya that in those areas where rice is grown as a commercial money-crop there is a keen interest by the growers in the drainage and irrigation of the lands being put into a satisfactory condition and there is no objection to interest on the cost of such work and maintenance charges being recovered in the land rentals according to the yielding capacity of the land. There is also a demand in these areas for pure-line seed padis which have been evolved and multiplied by the Department of Agriculture. This demand is being stimulated in Perak by the offer of a small premium for all such padi, if of approved quality, delivered to the Perak State Rice Mills.

In the new areas being developed under irrigation, such as the Sungei Manik Scheme, colonization is tending to lag behind the areas which have been made available for cultivation. This scheme has been developed in three stages and the lag in colonization has not so far been serious. There are, however, definite indications that colonization is not at the present time proceeding as rapidly as could be hoped for. Ten thousand acres have been provided with drainage and irrigation so far and of this area some 7,000 acres have been alienated. Surveys have also been completed for an extension of the area to the extent of 24,000 acres of irrigated land and 7,000 acres of higher kampong land. There is no doubt that this provision of kampong land should prove attractive to the prospective colonists, as there is clearly an insufficiency of such land in the areas originally brought under the scheme, and judged by Ceylon standards it seemed to me that there had been an insufficient provision for roads. It was urged that the paths provided, where transport was possible in the channels or streams, would be sufficient for Malayan needs, but I still feel that whilst the provision may be up to present-day conception of the needs of the cultivators, it is unlikely that they will be accepted as adequate say ten or twenty years hence, when, as the result of the spread of education, greater facilities for movement to and from the padi plots and to schools and markets will, not without reason, be demanded. In planning the new extensions, I would therefore urge that most careful consideration be given to this question of the provision of roads and would suggest for consideration that visits by the Irrigation Engineers concerned to Ceylon and possibly South India might be advisable in order that the characteristic features of the irrigation schemes for padi in those countries may be studied on the spot.

Padi cultivation does not provide at the best a high margin of profit and when it has to compete, as it does in Malaya, with rubber it does seem important that the most careful thought should be given in respect of the extensions proposed to the transport facilities required, in addition to provision of the domestic water supplies and sites for mosques, public buildings, schools, dispensaries and grazing grounds already contemplated.

One cause in the lag in colonization at Sungei Manik has clearly been the increase in the value of rubber during 1937, but another difficulty which is being experienced is due to the fact that the type of padi best suited to the area has not yet been determined with certainty. The Department of Agriculture is making careful tests and in a few years time it may be anticipated that the answer to this problem will be determined. There were areas at the time of my visit which had been planted by growers with padis of the incorrect age-period

and the suggestion was made that when land was brought into cultivation it might be found advantageous to sow for one and possibly two seasons, as is the custom in Ceylon when new land is brought under irrigation, dry-land padis. These are usually of a more hardy nature than the wet padis and give better average crops when there is any irregularity in land levels or insufficiency of water supplies. In newly-planted lands it was stated that yields averaged about 230 gantangs per acre as against 375 gantangs in the older areas. It is possible that by using the hardier dry-land padis the yields from the newly-opened areas, especially where land levels are at all irregular, could be increased during the earlier years. These years are critical periods as far as the colonization of new lands is concerned.

It must be recognized, however, that taking the Malayan padi area as a whole there has been a general decrease in the areas devoted to dry-land padis and a corresponding increase in the areas devoted to wet-land padis. It is difficult to find an explanation for this fact, especially when it is recognized that the bulk of the dry-land padi is grown in the States of Kelantan and Trengganu, where there has so far been little attention given to controlled drainage and irrigation under Government supervision. When conditions are favourable and irrigation waters can be relied upon, wet-land padis normally give crops 50 per cent. higher than where dry-land padis are grown in areas dependent upon rain, but when the conditions are not favourable for wet-land types they often give only miserable returns as against reasonably good yields from dry-land types. Any trial of dry-land types in the Sungei Manik Scheme should be of an experimental character, but such a trial appears definitely to be warranted.

The question of padi cultivation in Kelantan deserves special consideration. One-fifth of the total area under rice in Malaya is found in that State but its production is only about one-seventh of the whole crop. It cannot be contended that its lands are as fertile for rice production as are some of the lands in other States in the west of the Peninsula, but the cultivation methods of the growers are good and improvements in these methods are only to be looked for if a system of husbandry can be devised whereby increased quantities of organic matter or of organic manures are made available for incorporation in the soil. The main drawback to the industry is the inadequacy o water control and there is little doubt that greater stability would be given to the industry, greater uniformity assured in the crop reaped and an extension of the area under wet padi at the expense of the areas now planted perforce with dry padis made possible, if schemes for controlled drainage and irrigation could be adopted. Some small schemes have been undertaken both in Kelantan and the neighbouring State of Trengganu and

general preliminary survey of the position has been made. It is felt, however, that the State of Kelantan cannot from its own resources finance any large schemes of drainage and irrigation, nor provide the funds necessary for the maintenance of a Resident Irrigation Engineer. This is to be deplored, if Kelantan, with its suitability for padi production and its industrious and knowledgeable population, is to fufil its rightful place in the production of its quota of rice towards the requirements of the peninsula. In recent years, Kelantan has in fact been on balance an importer of rice and it has often been found difficult after good harvests to explain why this should have been the case. It is accepted that at times some measure of hoarding in the State has taken place. Floods and droughts have been the cause of the great variability in the crops harvested and there seems to be little doubt that production could be increased by at least 25 per cent. and possibly more if the drainage and irrigation of the padi lands were satisfactorily controlled. Crops would, as the result of such action, be more uniform and secure, and until this is achieved it is unlikely that an export trade in rice of any importance to other parts of Malaya will be established. There can be no doubt that from an agricultural and economic point of view there is a definite need in Kelantan for a Drainage and Irrigation Engineer with specialized knowledge if improved administration of irrigation areas and sound development is to be secured. Whether large-scale irrigation schemes are practicable is not accepted as being certain, but there are numbers of small schemes which could with advantage be improved and developed. Similarly, there are numerous small schemes possible in the neighbouring State of Trengganu to which expert attention should be given. I therefore support the suggestion that has been made by the Adviser for Drainage and Irrigation to the Malay States to the effect that means should be found, without delay, of providing for the appointment of a Senior Drainage and Irrigation Engineer for combined duty in the States of Kelantan and Trengganu, with the object of making a continued study of the needs of padi cultivators of the two States and preparing plans for the construction of irrigation and drainage works. No work, other than the further development of roads, is likely to be so remunerative to the State and more conducive to orderly development than the control of irrigation areas and the construction of irrigation and drainage works under expert guidance.

The soils on which padi is grown in Malaya show marked variations. In Perlis the soils are light loams inland and heavy clays in the coastal areas. In Kedah the soils are moderately heavy loams, whilst some of the lands nearest the coast are heavy clays. Cultivation is normally done by ploughing with buffaloes or cattle. In the Krian area of Perak

the lands are very deep, full of decaying organic matter and sometimes inclined to be somewhat peaty in character. On such lands the use of animals for cultivation is quite impossible, and hand cultivation alone is practicable. In Pahang, certain swampy areas are so deep that ploughing is not possible and " mudding " with buffaloes is practised. In Kelantan, the soils are light in character, being inclined to be sandy. They are easy to work and ploughing by cattle is general. In Malacca, the older padi lands resemble closely many of the older areas found in Ceylon and are moderately heavy loams or clays.

The methods of cultivation vary in the different parts of the Peninsula. Good ploughing is done in Kedah with a useful locally-made wooden plough with an iron share, but in Kelantan even better work is done and the wooden plough of that State is the best indigenous agricultural implement that I have seen anywhere. It is a really good and efficient plough, well made and well suited to the work for which it is required in the moderately light soils of the State.

In Krian, where the land is deep and the intercrop vegetation rank, the cultivation consists simply of cutting down the growth of vegetation by means of a short-bladed scythe—known as a *tajak*—rolling this vegetation about a week later into heaps to assist rotting, and between four and five weeks later removing anything which has not fully rotted on to the bunds which divide the fields.

Where ploughing is done, as in Kedah or Kelantan, it is usual to plough twice and then to break down the ploughed surface by means of a fluted roller. This helps to bury the weed growth and to smooth down the surface of the land. These rollers are of different lengths, and the flutes are of varying depths. The Kedah roller is smaller than that employed in Kelantan and there is no doubt as to its great value as an implement for use in padi cultivation. The Department of Agriculture is now making trials with its use in areas to which it has not so far extended. Final smoothing of the soft mud after an inch or two of water has been let into the fields is done by means of an implement similar to the Burmese harrow or by means of a buffalo-drawn levelling board.

In certain areas, preliminary work has to be done by hoes instead of by ploughs and in these places the final levelling is done by hand-operated levelling boards—as is the case in Ceylon. The whole art of successful padi cultivation depends upon the satisfactory incorporation into the soil of the padi stubble of the previous crop and the weed growth and the creation of a good " puddle ". If this is not done, unsatisfactory growth in the newly-planted crop results and it may be choked by weeds. Early weed growth is the greatest enemy to successful padi cultivation, whether of the dry-land type or under irrigation.

The outstanding feature of all wet padi growing areas in Malaya is that all the padi is *transplanted*. There is no broadcasting of seed in wet padi areas, as in Ceylon. Even in Kelantan, where dry-land padi is grown, the land is thoroughly ploughed and harrowed four times in order to kill off weed growth and the seed is dibbled to form clumps of three to four plants each in lines at spaced intervals. Broadcasting is only used on undulating dry lands and that to a very limited extent, where the land is sown with special types of paddy for two to four crops alternating with three to five years under pasturage or secondary bush growth.

In order to provide the plants for the nurseries considerable care is taken. These nurseries may be made (*a*) on dry ground, (*b*) in a puddled corner of a padi field, or (*c*) in Krian by means of a peculiar system of floating nurseries locally known as *rakits*. These floating nurseries are specially constructed of heaps of weed growth on which a clay covering is plastered. On the top of this is placed rich earth which forms the seed bed for the receipt of the seed. These floating nurseries are made so that when the water level in the field rises, the nurseries of young seedlings also rise. Plants from these floating nurseries are transplanted into clumps into the field and these are subsequently subdivided into smaller clumps, from which eventually seedlings are taken for putting out into the fields.

Transplanting of padi seedlings into the fields is usually done by women, two to six plants being planted out together at distances of six to twelve inches, according to the fertility of the land. In Perak and Kedah a planting tool is used, but in other areas the seedlings are simply pressed into the mud. Attention is not given to the same extent as it is in several other rice-growing countries to the age of the seedlings used for transplanting, nor is so much attention given to the regulation, when such is possible, of the depths of water used for irrigation. Further refinements in the drying off of fields before harvest are also possible.

Some manuring is done with bat manure collected from caves in Perlis and with composts made with animal droppings in parts of Kelantan.

Nearly three-quarters of the crop is harvested by the *Tuai*—a small knife set into a wooden base which fits into the palm of the hand. By means of this knife each head is cut separately with a few inches of straw attached. The bulk of the straw remains and no use is made of it. It is eventually worked into the soil again to provide organic matter for the next crop. In a few areas the burning of the stubble is practised. When the *Tuai* is not used—and this is generally in areas where padi is grown as a commercial crop—the sickle is used. There is some tendency for the extension of its use, but this extension is slow as the superstition concerning the spirits of the padi

fields extends from China, through Malaya, to the full length of the Netherland East Indies and this superstition ensures the continuance of harvesting the heads of grain individually, even if the labour and time so involved is considerable.

The Department of Agriculture now carries out field experiments at eight main stations and forty-three padi test stations. These are distributed as follows:—

	Main Stations.	*Padi Test Stations.*
Straits Settlements		
Penang and Province Wellesley	1	2
Malacca	1	2
Labuan	—	1
Federated Malay States		
Perak	3	10
Selangor	—	5
Negri Sembilan	—	3
Pahang	—	6
Unfederated Malay States		
Kedah	1	6
Johore	—	3
Kelantan	1	2
Brunei	1	3
	8	43

Arrangements have also recently been made for the establishment of a new station in Kelantan to study problems connected with the cultivation of dry-land padi.

Detailed pure-line selection by the ear to row method is maintained at six of the main stations whilst the test stations are used for the preliminary selections from local varieties, for the testing of the suitability for the locality concerned of the pure-line strains issued from the main stations and for the multiplication of seed of pure-lines recommended for distribution. Manurial trials are also made at a number of the stations.

The whole of the work in regard to padi experiments was reviewed in 1933, and from that time the work at the different stations has been standardized. Marked progress has been made and it is clear that as the result of working to standard instructions, much improvement has been effected in the degree of reliability of the experimental work undertaken. The work at the stations now includes, in varying degrees—

(*a*) pure-line selection work,
(*b*) variety trials,
(*c*) multiplication plots, and
(*d*) manurial trials.

On examination of the system, it would, however, appear that the time has arrived when a greater measure of flexibility could with advantage be introduced. In certain areas, for instance, Krian, where intercrop growth of vegetation is considerable, it is unlikely that any increased yields would be obtainable from a system of green manuring, whilst in the old worn-out lands, of say, parts of Malacca, the importance of added organic material cannot be overstressed. The importance of organic matter in Kelantan padi lands also cannot be overstressed.

It also appears that some of the best local varieties were not used in the earlier tests between local types and pure-line strains, and this has led in some cases to selections having to be extended over a wider range than was originally contemplated. In many of the test stations there was clearly a very large number of pure-line types under test, whilst it was not always apparent that local types were being used as controls in these tests. Reductions of numbers is desirable as soon as it is considered to be practicable. Plant selection work demands that drastic discards of material should be made from time to time, if the workers are not to be swamped by the mass of material collected or produced. Difficulties of this kind are bound to be encountered in any Eastern country in padi-selection work as the numbers of the varieties of padi are so numerous. Progress is often slower than in countries where rice is a recently introduced crop as there is so much material to work on and the growers themselves have their own views and fancies in regard to the types they favour. Unless care is exercised, rice-breeding officers may find themselves swamped with the mass of material available and pure-lines are often found difficult to establish in the eyes of the growers because they do not conform either in colour or some other minor characteristic with the standard local variety or varieties in general favour. A close examination of the position reached in Malaya should be contemplated within the next year or two.

There are, of course, obvious advantages in standardization of the technique for experimental work in connexion with any crop, and the advantages of the system have been adequately demonstrated with padi in Malaya. Less rigidity in the system is, however, now required and whilst I do not advocate decentralization to the extent that District or State Agricultural Officers should be entrusted with the sole charge of making plans for the work on the various stations in the areas under their charge without reference to a central co-ordinating authority, I would recommend that these officers should be given greater freedom in the trials laid down in connexion with cultural problems and in determining which local varieties shall be used for the determination of the value of the pure strains evolved. In deciding the amount of authority which

should be accorded to the District Agricultural Officers in regard to padi work, account must be taken of (*a*) whether the padi being grown is for consumption in the area itself, and (*b*) whether it is being grown commercially for sale to central mills either in the area or elsewhere. This is fully recognized in the Department for it has been recorded that the extent to which a selected pure-line strain is made use of by the cultivators varies in different areas and depends, in the main, upon whether padi is grown as a commercial crop or solely to provide food for the grower and his family. In Kedah, the Krian district of Perak and in Malacca, padi is a commercial crop and high yielding pure strains have met with a ready demand. In Kedah five different strains are favoured, whilst in Malacca, where the demand for seed exceeds the supply, there are also five pure-line varieties of proved value. Siam 29 is a type greatly favoured and it is also a favourite in Kedah. Selections from Radin and Nuchin padis are also popular. In Perak, the Seraup 48 is the most favoured and at the Government Mills at Bagan Serai and Parit Buntar one-half of the padi purchased was of this variety and of the quantity tendered one-third qualified as far as standard of purity was concerned for the special premium offered.

The Department of Agriculture has made its policy cover the following items:—

(1) To determine, by experiment, the most suitable season for padi in the various parts of the country.

(2) To secure, in collaboration with the Drainage and Irrigation Department, the optimum conditions for the growing of the crop by the regulation of planting dates and supplies of irrigation water.

(3) To investigate and develop the possibility of improvements of yield by improved cultural methods, manuring, and the use of high yielding pure-line strains.

(4) To assist in the work of opening up new areas under padi.

There are reasons for thinking that the present planting dates in Negri Sembilan and Pahang are not the dates for optimum yields and the revision of dates at Sungei Manik proved to be beneficial.

Data secured from manurial trials are somewhat contradictory and a revision in this part of the Department's work might be contemplated. On some of the stations, the conditions on some of the manurial plots were unsatisfactory. Water stagnation had resulted from the use of small plots with well-defined bunds and conditions such as these are inimical to satisfactory growth of padi, which is a crop that requires a regular and satisfactory supply of water but does not tolerate stagnant conditions in

this water of irrigation. There is ample evidence from rice-growing countries which goes to show that irrigation water for successful padi cultivation should either be moving or be moved artificially at regular intervals if the best results are to be obtained.

It is also unlikely, as has been indicated earlier in this section, that improved yields will be secured from the use of green manures, except in those areas where the natural supply of organic matter is low. It can be accepted generally that when the intercrop growth of weeds or vegetation is profuse, little improvement can be secured by the use of green manuring. The introduction of a sown green-manure crop between crops of padi is often difficult to secure, and in certain areas where the indications are such that benefits might be expected from green manuring, I would suggest the trial of the Ceylon system of lopping off the smaller branches and leaves of the shrubs grown on the higher kampong lands on the edge of the padi-growing areas for removal to and ultimate incorporation in the land sown with padi. Such a system should offer promise of success in Kelantan, and also possibly in parts of Kedah and Malacca. In Kelantan, also, when the water table of padi lands rises to a high level in the wet season, the trial of species of Sesbania would appear to be warranted. *Sesbania aculeata* has been found useful in India and parts of Ceylon, when conditions were too "swampy" for *Crotolarias, Indigoferas* and *Tephrosias.*

It is also probable, and trials are to be made to test this point, that in those areas where cattle and buffaloes are maintained for use in padi cultivation, increased yields would result from the use of farmyard manure or composts. Animal husbandry in padi-growing areas is still in a very primitive stage of development and improvement is unlikely to result if attention is confined solely to the increased provision of grazing grounds. To develop a system of "mixed" farming whereby animals are utilized in connexion with agricultural practices and the manuring of lands should be one of the main objectives of the Department of Agriculture. Soil fertility will thereby be improved, crop yields increased and an improvement in the class of animal assured. The importance of organic manures in padi cultivation has been recognized for several generations in the Jaffna Peninsula of Ceylon, with its thin padi lands, and there is every reason to believe that beneficial results would follow the adoption of a similar system in Kedah, Malacca and Kelantan.

Investigations and experiments have shown that the cultural practices in the older padi-growing areas of Malaya are generally sound in principle and that the methods and implements used are suited to the conditions which prevail. In parts of Pahang,

methods and implements are inferior and considerable improvements have been brought about by the introduction in recent years as the result of demonstrations on the Padi Test Stations and of visits arranged for Pahang cultivators to other parts of Malaya, in order that they might see for themselves the methods and implements there employed. The results which have been achieved so far are most encouraging.

Tests have also been made since 1930 with mechanical cultivation at the Pulau Gadang padi station in Malacca. These tests have demonstrated that the conditions in Malaya are unsuitable for mechanical cultivation in connexion with padi-growing and it has been decided that experiments in this direction should be discontinued. I was able to discuss the various factors which make it impossible to adopt under Malayan conditions mechanical systems of cultivation for padi and there is no doubt, from the records which were shown to me, that there was an even chance of an uncertainty in Malacca in regard to the rainfall at the moments which are essential for success. I am therefore satisfied that the decision to change over from mechanical cultivation at this Station to cultivation by means of buffaloes is sound. This change will make it possible to make tests of " mixed " farming methods suitable for padi-growing areas and of the value of the stall feeding of animals, with the object of producing organic manures for use in the fields.

In general, it can be said that the work of the Department of Agriculture in regard to padi cultivation has been carefully organized and well performed. Progress has been made in a number of directions and plans for future developments are under contemplation. Pot experiments, for example, have been made at Kuala Lumpur to test the effects of mining slimes on padi and field trials are shortly to be undertaken. Certain proposals for a measure of decentralization of some of the work have been indicated and further developments in the agricultural aspects of the cultivation may be foreshadowed. The development of animal husbandry in connexion with padi-growing and the preparation of farmyard manures, whether by means of cattle or buffaloes, in the older established areas such as Kedah, Malacca and Kelantan are clearly directions in which further work is necessary, if advances are to be made in a cultivation which is so essential to the welfare of the Malays.

Padi is husked in the kampongs in Malaya, either by means of pestles and mortars or by means of a small hand-operated mill. The former are of different design and the pestles may be operated by hand or be attached to levers operated by the feet. The small hand-mill is an ingenious development and is a useful machine for turning out small quantites of rice for domestic use. A larger ox-driven mill of the same pattern

is used in Kelantan. The padi may be milled dry or after it has been par-boiled. It is broken rather heavily, whether the pestle and mortar is used or the hand mill employed.

Rice milling has been developed as a business by the Chinese and a number of privately-owned rice mills operate throughout Malaya. They usually turn out either white or par-boiled rice and there is a certain tendency to the formation of rings with the object of depressing prices to the growers for their padi. Visits were paid to a number of these mills and also to the newly-erected mill under European management in the State of Kelantan. The Government of Perak have, by the establishment of Government mills, endeavoured to stabilize the position. Visits were paid to these Government mills in the State of Perak. These are well-equipped and it has been established that so far these mills, which deal with 25 per cent. of the padi grown in the area, have had the effect of stabilizing prices, not merely in the defined area of their operations. The stabilization which has resulted from the establishment of the mills under Government control in the State of Perak has definitely been beneficial to the industry. It has also been found at these mills that rice to which 5 per cent. of slaked lime is added can be stored for considerable periods free from weevil attack.

These Government mills are now turning their attention to the production of an under-milled rice and to improvements in the production of par-boiled rice, and considerable interest is being displayed in this effort to produce a rice of a much higher nutritional value than the usual white rice, which by the removal of the endocarp is robbed of much of its food value. There is no doubt that Eastern countries can make no greater contribution to the cause of nutrition than by the encouragement of the production of under-milled rice and Malaya, through its Government-controlled mills, is well placed to take the lead in the furtherance of this movement. Further investigational work on the par-boiling of rice is also required as there have been recent changes in the system of par-boiling. It is customary at some mills to soak the padi for a much longer period than was formerly the case and it is possible that by this change of system the water-soluble vitamins which were soaked under the old system into the " grain " are leached away into the water in which the padi is soaked. It is therefore suggested that trials should be made at the Perak Government Mills, in collaboration with members of the chemical staff of the Department of Agriculture and the research workers at the Medical Research Institute, to determine the method which should be adopted for the production of a par-boiled rice of the highest nutritive value.

Co-operative societies amongst growers have spread but slowly except in Kedah but they are beginning to develop in

other States since a system of seasonal advances was inaugurated. In Kedah, a paddy bank has been established by H. H. Tunku Yacaob, the State Agricultural Officer, and this bank makes seasonal advances for cultivation purposes. The development of credit facilities is clearly needed amongst the padi growers, but progress, if it is to be on a sound foundation, is likely to be slow.

In conclusion, it may be said that very sound progress is being made in connexion with the problems which face the padi-growers in Malaya, and that further development is to be expected within the next few years. Indications have been given as to the directions in which further work is required and it is to be hoped that the interest which the Malayan Governments have taken in rice production will be maintained without abatement. A greater proportion of the peninsula's requirements of rice should be produced locally, before it can be felt that the food situation is on a thoroughly sound basis, and particularly would I emphasize that it seemed to me that much greater attention should be given to padi cultivation in the State of Johore and that the position in Kelantan in regard to drainage and irrigation required to be placed on a more satisfactory basis. I would also desire to direct the attention of rice-producing countries elsewhere in the Colonial Empire to the Kedah and Kelantan ploughs, the useful fluted roller used in the same States, the Burmese model of harrow used in cultivation and the small hand-mill used for the production of rice for home consumption. Importance should also be attached to the influence which the Government-owned mills have exercised in the State of Perak in stabilizing prices, preventing buying rings, and ensuring an outlet for padi from newly-developed areas.

Coconuts.

The area under coconuts in Malaya is estimated to be 609,417 acres. About 80 per cent. of this area consists of Asiatic-owned smallholdings. In terms of copra-equivalent the net domestic exports amounted in 1937 to 142,100 tons and the local consumption to approximately 57,000 tons.

Cultivation methods on estates are, on the whole, good, and in recent years there has been a very marked improvement in the general standard of the copra produced. This improvement in quality is the direct result of the appointment in 1930 of a Coconut Research Officer. Prior to that date copra-drying was thought to be a secondary consideration to efficient field production. The few estates then producing good copra were using hot-table driers or specially protected sun-drying barbecues, as there are only two localities in Malaya where sun-dried copra can be satisfactorily prepared and then only during the dry season. The majority of the estates favoured

low cost production, regardless of quality, using smoke-kilns of simple construction. On most of these estates, no extra provision was made for normal crop increases and in consequence kilns were frequently too grossly overloaded for satisfactory drying. Quality invariably declined in the wet season.

From 1930, attention has been directed by the Department of Agriculture to the improvement of copra production and careful study was made of kiln construction. At the present time it is estimated that 90 per cent. of the estate copra is produced in improved kilns built according to the recommendations of the Department of Agriculture. Estate copra is now generally above the Straits *f.m.s.* (fair merchantable sun-dried) standard and much of it compares favourably with Ceylon *f.m.s.*

There is little cultivation given on smallholdings. Some areas have, however, suffered from inundations from sea water. Such areas are to be seen in the Bernam peninsula in Selangor and in the Rantau Panjang area of the same State where marked improvement in the appearance and yields of the palms has followed their protection from inundation by sea-water by means of coastal bunds. The Bagan Dato area in Perak is also an example of the beneficial results obtained from bunding. I visited in company with officers of the Drainage and Irrigation Department and of the Department of Agriculture an area in Johore where losses of a considerable acreage of coconuts had taken place in consequence of sea water inundation. It was obvious that this inundation had followed upon land shrinkage as the result of drainage and cultivation. In some places the palm roots clearly showed that the shrinkage had been as much as two to two and a half feet and it was clear that the area would only be saved for cultivation by the building of a bund to keep out sea-water and by the regulation of the drainage. Experience in Holland has shown that in low-lying lands of a peaty character the regulation of the water-table is of equal importance to the protection works against sea inundations if land shrinkage is to be avoided. The regulation of the water in the dykes of Holland has been developed to a fine art, for it has been found that in certain types of land the maintenance of the water-table at a determined level and the water content of the soil at a given percentage is essential if excessive land shrinkage as the result of cultivation is to be avoided. In many areas of Malaya too little attention has been given to this matter and too much emphasis has been laid on the drainage of water away from the land rather than the regulation of its water content. This is specially applicable to lands inclined to be peaty in character.

Formerly the drying of smallholders' copra in the kampongs was carried out almost entirely by Chinese middlemen. Except for a few kilns in Johore, the kilns used were of the most primitive type and the nuts usually bought were immature. The

question of the quality of the dried copra received no consideration and as much moisture as possible was included, the product being over-smoked to check rapid decomposition. There was a movement in 1930 by Malayan growers to produce kiln-dried copra. These kilns were of poor design but during the next two years increasing numbers of Malay smallholders produced copra in kilns made of *attap* (plaited palm leaves), wood or galvanized iron. The quality of the product was not satisfactory and in 1932 a small brick kiln of improved pattern was designed by the Department of Agriculture and 12 of these kilns were erected. The efforts of the field officers of the Department of Agriculture to popularize these kilns were only partially successful because of their cost.

It became obvious that there was real need for an inexpensive kiln of improved design. Extended investigations were made by the Chemist for copra problems and in 1936 a series of small kilns were evolved to suit various sizes of smallholdings. These kilns were so designed that a material reduction in the time of drying was effected whilst the production of a commercially white copra was made possible with the minimum of attention. These kilns have proved to be very popular, but on account of their small size they are sensitive to climatic conditions and require more fuel in the wet season to produce dry copra than during the dry season. They also work better by day than by night. Further attempts are being made to effect improvements and it is hoped that eventually kilns will be evolved which are completely satisfactory for the night operation which is preferred by the Malays.

The quality of kampong-produced copra still varies considerably, but general improvement has been continuous since the introduction of improved kilns and I saw at Singapore some kampong copra which was fully equal to estate *f.m.s.* Recently it has been more difficult to obtain price recognition for quality and this, it was reported to me, was resulting in many producers being inclined to offer an under-dried product. I am satisfied, however, that marked progress has been made since the introduction of the kilns designed for smallholders and that efforts to increase their numbers should be continued. In this connexion it might be advisable to have prepared sheets of type plans for distribution by the members of the field staff of the Department of Agriculture to producers contemplating the erection of kilns. Similarly, efforts should be made to encourage middlemen buyers of nuts to erect kilns of approved design and in fact it might be made a condition of their licences that such kilns are erected and worked. A similar recommendation has been made in the case of middlemen purchasers of wet rubber and as much of the lowest grade of copra now comes from middlemen producers attention should clearly be given to their methods of production.

Careful consideration has been given for some time as to whether the efforts made by the officers of the Department of Agriculture to improve copra should not be supported by grading under a system of produce inspection. A grading scheme on the Malayan Mark principle was proposed but it met with little or no response from the trade. Thought was then given to the feasibility of establishing legally defined grades and the inspection of all copra for export. For such a step to be justified, the expense of the inspection and grading would have to be more than covered by the return secured from increased prices realized from improved quality. There is approximately a difference of about 17s. 6d. per ton between *f.m.s.* copra and *f.m.* It is doubtful if the result of raising the standard of the present highest commercial grade would be remunerative as the price differences realized would be small and similarly it is unlikely with the existence in Malaya of the standard estate grade whether such increase in price would result on account of greater confidence of the trade in the reliability of grades by reason of grading being done under Government supervision. The Director of Agriculture has collected information and figures on the issue and after consideration of the available data I agreed with the conclusion that he had reached that at present it appears to be very doubtful if the benefits of compulsory Government grading would justify the expense. It seemed to be preferable to concentrate all the efforts of the staff available to the raising, by means of an extension of kilns amongst smallholders and middlemen, the present production of *f.m.* copra to the *f.m.s.* standard That it can be done is clearly indicated from the samples which I saw in Singapore. The Malayan smallholders' copra was already of higher standard than much of the copra imported from the Netherland Indies and some of the samples were equal to estate *f.m.s.* If all the locally-produced copra could be raised to this standard material financial benefit would result.

The copra produced on estates and small-holdings in Malaya is exported from Singapore, Penang and Port Swettenham. There is also a large import from the Netherland Indies into Singapore and to a smaller extent into Penang.

Estate copra is either shipped direct to Europe or sold to merchant shippers or to oil mills. It usually commands a premium as it is dry enough to ship at once or to be used to "brighten" copra of lower quality. Small-holders' copra always passes through a chain of middlemen—the length of the chain depending largely upon the locality of production. Efforts to shorten the chain have been of no avail as all attempts at co-operative production, co-operative sale or sale through estates or kiln-owners associations have ultimately succumbed

to changes made in the conditions of marketing. Copra imported from the Netherland Indies is generally inferior to the Malayan production and it is almost invariably up-graded with slightly better copra or used in the oil mills as soon as possible after importation in order to avoid further deterioration.

As recommended at the export centres, copra is described as " estate ", " sundried " or " mixed " with the name of the locality of production attached. " Estate " copra is commercially dry, is ready for shipment on receipt and is generally above the top export grade. " Sundried " consists of copra of good quality—i.e. internally white and non-rubbery, whilst " mixed " copra, as the name implies, consists of a mixture of good and bad copra in varying proportions.

Formerly all " Straits " copra was prepared for export by European merchant shippers who bought direct from estates or through Chinese dealers. The copra was inspected as received in small consignments and graded into two export standards, a bulked average of good quality *fair merchantable sundried* (*f.m.s.*) and the poor quality *fair merchantable* (*f.m.*). It was either up-graded, down-graded or bulked to these standards by picking over to remove good or bad pieces or by the addition layer by layer of superior copra to copra below standard in order to " brighten " the bulked consignment. Owing, however, to the increasing competition for copra between the local oil-mills certain changes in procedure have taken place. The mills started to buy wet " mixed " copra at a flat rate and to pay for it on delivery. The European merchant and shippers were unable to buy copra on this basis and Chinese middlemen who were prepared to take the risk have entered the trade. These middlemen buy " mixed " copra on a flat-rate basis and dry, sort and bulk it ready for export. The shippers export the copra so bulked but now accept no responsibility for quality. They now only buy occasional consignments of dry copra which may either be bulked and shipped at once or only requires a limited period in the warehouses. Estate copra is bought in this way or else is shipped direct on a through bill of lading.

As considerable interest has been taken in Malaya and also in certain other coconut-growing countries in the Malayan dwarf coconuts, enquiries were made as to the present position.

It is generally supposed that dwarf coconuts were introduced into Malaya between 1890 and 1900 by Javanese and Banjorese padi planters in Krian but a quotation by Winstedt in *Malayan Folklore* suggests earlier introduction into the Peninsula. More than 3,000 acres have been planted with dwarf coconuts in Malaya since 1912, generally in relatively small areas except in two cases when areas of 700 acres were planted out. Three types—yellow, red and green occur. The yellow produces the

smallest nuts and has proved to be the least resistant to unfavourable soil conditions. The red type produces a poor type of copra, whilst the green type is generally preferred on account of its greater hardiness and size of nut. It has been found by experience that under favourable conditions the dwarf coconuts of Malaya are capable of producing high yields but that the limits of the conditions under which they thrive well are very narrow. They do not thrive on light soils or in dry localities and produce the best results if they can be irrigated.

It is generally assumed in Malaya that dwarf coconuts are self-pollinated and therefore it has been supposed that they are now genetically pure. Families planted out at the Coconut Experiment Station at Klang from selected mother trees support this view but their yield figures have been very variable. The conclusion has therefore been reached that either yield is not predominantly a genetic character or that the palms are not genetically pure.

Selection work in the normal tall coconuts has also been carried out by the Department of Agriculture and families from selected mother-trees have been planted out. These families show a very considerable degree of variation as between the different members and in only one family was a reasonable degree of similarity to be noticed. Cross-breeding work has also been undertaken and some of the hybrids between tall and dwarf palms seemed to be promising.

The soil of the Coconut Experiment Station is, however, not ideal for coconuts and the work of the Station in consequence suffers. If the breeding work is continued, a more suitable site for the testing of the types raised will be required.

Pineapples.

The Malayan pineapple-canning industry was started about 1888 in Singapore but later it extended to the State of Johore, where the largest area is now under cultivation. The area under pineapples in Malaya expanded from 59,000 acres in 1935 to over 75,000 acres in the following year. In 1937, the area was 75,345 acres, of which over 57,000 acres were in Johore.

Formerly pineapples were grown as a catch crop in young rubber but at the present time fully two-thirds of the acreage is grown with pineapples as the sole crop. This change of practice has led to a number of problems relating to the maintenance of soil fertility, and two Pineapple Experiment Stations, one at Lim Chu Kang in Singapore and another at Kota Tinggi in Johore, have been opened to study planting methods, periods of cropping, shading, the use of green manures, fertilizers, etc. The Singapore station is on poor, worn-out acid soil and growth

has been very unsatisfactory over the greater part of the Station. Attempts are now being made by means of green manuring to build up soil fertility, but it is extremely doubtful if this will be effected and the land may have to be placed under forest cover for some years.

A number of pineapple selections and hybrids are under test at this Station but much of the work is being ruined by the wilt disease, which is common at the Station. The wilt disease here was clearly the mealy bug wilt, which is common in most pineapple-growing countries, and this determination was subsequently confirmed by Dr. Carter, the Entomologist to the Hawaiian Pineapple Growers' Association, during his visit to Malaya in his round-the-world search for parasites of or predators on the pineapple mealy bug. Spraying against the mealy bug will have to be introduced on the Singapore Station if the selection and breeding work is to progress and this will also have to become a general practice at the Kota Tinggi Station in Johore, where a few cases of wilt were observed, but the occurrence of mealy bugs could not be found. Dr. Carter, however, on a subsequent visit to the Johore Station stated that the wilt there was true mealy bug wilt and that it was to be observed quite commonly in the pineapple cultivations in Malaya. Its effects are not serious on newly-opened lands of good fertility, but as soil fertility falls losses progressively increase.

Hawaii has recently introduced predators on mealy bugs from Kenya in the hope that one or other of the introductions will adapt itself to feeding on the pineapple mealy bug and similar introductions into Malaya would be worth contemplation. Otherwise, regular spraying with oil sprays should be adopted as the general practice on the Experiment Stations and possibly also in some of the cultivations.

From an agricultural point of view, the pineapple industry is passing through a transitional stage and much has yet to be learned as to the best methods of preventing soil erosion and of maintaining soil fertility where pineapples are grown in monoculture. The work of the Johore Experiment Station is therefore of great importance to the industry. It has been well laid out and an interesting series of experiments has been started. It should not, however, be overlooked and it is possible that under the soil and rainfall conditions prevailing in Malaya the rotation of pineapple cultivation with periods of shrub growth may be necessary, if the use of animal manures cannot be introduced into the systems of cultivation. Green manuring may be effective for a time, but it is quite probable that something more than green manuring will be necessary to maintain soil fertility under the wet tropical conditions which prevail if replanting is only done at intervals of five or six years.

The variety of pineapple grown for canning is the Queen and the outstanding feature of the cultivation is that the crowns are broken off from the fruit at an early stage. It is asserted that this results in a more uniform shape of fruit and in more regular ripening. Some Smooth Cayenne is grown for table use but it is not suitable for canning under Malayan conditions because the fruit grows to a size which is too large.

Efforts have been made in recent years to improve canning practices and much has been done to improve the hygienic conditions in the factories. Many factories have been rebuilt and nearly all are now up to the standards required by the Health Authorities. Improvements in methods of processing, supervision and equipment are still required, but funds have been provided for the establishment of a Canning Research Station near Johore Bahru for the use of the Canning Officer. A model demonstration factory will be erected at this Station and it is hoped that this will assist materially towards the encouragement of canners to effect improvements in their factory equipment, in their processing methods, and in the maintenance of standards of quality.

The Governments of the Straits Settlements, Johore and Selangor, after consultation with representatives of the industry, agreed to enact regulations under the Pineapple Industry Ordinance and Enactments to provide for the standardization of the sizes of cans employed and agreement was reached for the introduction of a grading scheme under a Malayan Mark. These are definite steps forward in the reconstruction of the packing side of the industry and the application of the Mark will not be allowed unless the quality of the product conforms to the specifications which have been framed for the " Golden " and " Standard " grades.

The industry by reason of over-production and cut-throat competition between the packers was at the time of my visit to Malaya passing through a period of acute depression. Prices had fallen to below cost of production and there was complete disorganization in the industry. It seemed that if the industry did not take steps to remedy the position it might be necessary for the Government to intervene. Discussions and deliberations were taking place as to the best measures to adopt to save the collapse of the industry and it is satisfactory that agreement was ultimately reached that Government should be asked to take steps to limit the erection of new factories and to authorize the creation of a Central Control Board to regulate factory output and to control sales. This again is definitely another step forward and the details for making this scheme of organized production and marketing effective are under the consideration of the Governments concerned in consultation with the industry.

Tea.

The cultivation of tea is of comparatively recent origin. Before 1930 there were about 1,200 acres under this crop but at the end of 1937, there were 3,615 acres planted on estates and 536 in smallholdings. Of the estate tea 2,035 acres were on upland estates and 1,580 on lowland estates. The estate production in 1937 was just over one million pounds, of which slightly more than half was exported. Prices averaged 1s. 2·9d. per lb. for upland and 1s. 1·7d. per lb. for lowland teas—the upland prices being equal to the average of Indian teas and the lowland prices of Java teas.

Several tea estates were visited, particularly in the Cameron Highlands. Cultivation methods are on the whole good, and yields are satisfactory for new land. Some of the teas made border upon quality teas, but the majority have no outstanding flavour. The liquors are good and bright. Many of the areas being opened in the Cameron Highlands are steep in slope, although steeper lands have been in fact opened in Ceylon. Rainfall averages about 100 inches per annum but the falls are not heavy. Terracing is not practised and contour drains are not frequently used. It was in fact stated that the soil was normally very absorbent but landslides occurred if there were accumulations of water in drains or silt pits. Under these circumstances use should be made of soft weeds or other ground cover, as in Java, or contour hedges of close-growing shrubs or grasses like *Vetivaria zizanoides*, employed as checks to erosion. *Dymeria* is a common weed and *Vigna oligosperma* is being established on some estates as ground cover. *Indigofera endacophylla* also grows well in the area but may in fact be a little too luxuriant unless it is lopped at regular intervals.

Certain patches of tea were inclined to show some yellowing and it might be worthy of investigating whether this condition could be counteracted by applications of sulphur or by manuring with sulphate of ammonia. Root diseases also occur in patches.

Further information is required by the industry in regard to pruning cycles and a series of tests could, with advantage, be carried out on the tea area of the Cameron Highlands experiment station. The correct pruning treatment for the area has yet to be determined.

Discussions naturally centred around the acreage which Malaya might secure for tea-planting during the next restriction period. As the matter is still *sub judice* it is inadvisable to deal at any length with these discussions. Under the International Tea Regulation Agreement, Malaya undertook that the area planted between the end of 1936 and 31st March, 1938, should not exceed 3,000 acres, bringing the total area under tea in Malaya up to about 6,000 acres. It was, in fact, estimated at the time of my visit that the actual acreage on 31st March, 1938, would be

5,391 acres. Malaya has considerable imports of tea, the figures for 1937 being 2,709,302 lb. of black tea and 2,171,325 lb. of green tea. These imports are, however, only about one half of those which ruled prior to the depression period which began in 1931 and it is claimed by Malayan tea interests that the area planted with tea in Malaya should be permitted up to the acreage which would produce the total quantity of tea required for local consumption. If this view is accepted, it is clearly desirable that the Department of Agriculture and the tea interests should co-operate together in working out methods for the production of green tea in the forms most appreciated in the country. The imports of green tea for local consumption have increased materially, being in 1937 more than double what they were five years previously, and it is obvious that if Malayan requirements are to be met locally the production of green as well as black tea should be undertaken. Green-tea drinkers normally prefer teas of pronounced flavour, and it is from the higher elevations alone that such teas would be obtainable under Malayan conditions, especially where Indian jats have been planted in preference to the China hybrid sorts. In assigning new areas for tea planting, it therefore seemed to me that preference should be given to the upland areas and, in fact, it is probable that should the International Tea Regulation Agreement terminate the upland estates alone would be able to compete profitably in world trade for black teas and even then their margins of profit would be small.

Fruits and Vegetables.

Interest in fruit cultivation has increased during the past few years and greater attention is now being given to fruit production. There is, however, much more work that should be done in regard to fruit. The Serdang Experiment Station has in hand work with fruits and there is a steady demand for budded plants from all agricultural stations. Experiments with fruit canning have been made by the Department of Agriculture and the best results were obtained with tree tomatoes from the Cameron Highlands. A small commercial fruit-canning factory has started operations in Penang.

The fact remains, however, that Malaya imports 19,000 tons of fresh fruit and 9,000 tons of dried or canned fruit annually. Some of this could be replaced by locally grown produce, as also could part of the imports of vegetables which now amount in total to over 60,000 tons per annum.

The fruit work of the Department of Agriculture has been restricted by reason of the lack of suitable land at Serdang. Since 1934, concentration on vegetative propagation has been adopted and recently liaison with the officers in the Field Branch of the Department has been placed on a satisfactory basis. A

Serdang Clonal Register has been established. The fruit work in the Field Branch consists of the propagation by budding of several clonal types of the major fruits for distribution. These include avocado pears, durian, rambuttan, pulasan and various types of citrus. Work on mangoes for certain localities is also required and has already been alluded to in early portions of this Report. Pomelos also seem to warrant attention.

There seems to be no doubt that fruit cultivation could be extended with general advantage—both economic and nutritional—in the kampongs and that there is adequate justification for the creation of a post of Horticulturist or Fruit Specialist in the cadre of the Department, with financial provision for a central fruit station of 30-50 acres in extent.

It is doubtful if satisfactory progress will be possible under the existing arrangements and I am satisfied that the present experimental programme is quite inadequate to the needs of the situation.

Vegetable production is in the hands of Chinese market-gardeners, who with supplies of manure from the pigs which are kept by them maintain soil fertility at a high level. They are efficient producers and their industry, especially near the towns, is rewarded by profitable returns. Vegetable growing—especially of certain temperate climate vegetables—is now established in the Cameron Highlands and 387 tons of vegetables were sent from that area by rail during 1937. Pests have been troublesome but some of the more common ones are capable of being controlled by the use of powdered derris. This insecticide is commonly employed by vegetable growers with success around Bandoeng in Java and a greater use of it in Malaya is indicated.

The Agricultural Officer now stationed at the Tanah Rata Experiment Station in the Cameron Highlands is giving increased attention to the production of vegetables, fruits and flowers. The making and use of compost is receiving special attention, for the successful cultivation of vegetables depends upon the use of compost in combination with farmyard manure. A special area near Ringlet has been selected for experimental fruit work as there are indications that some of the present fruit imports of Malaya could be met by production in the Highlands.

Other Industries.

It is unnecessary to give in any great detail here particulars of other industries.

The cultivation of *oil palms* continues to expand slowly and the area planted at the end of 1937 was 69,000 acres. Production of palm oil continues to increase by reason of the higher proportion of cultivations reaching the full bearing stage. Manuring with phosphates ensures the maintenance of yields

but some estates in co-operation with the Department of Agriculture have laid down series of experiments to ascertain the response of oil palms to different fertilizers on different types of soil.

It is generally held that the cultivation of oil palms is more profitable to estates than the cultivation of coconuts. Some areas on undulating hilly lands were showing signs of yellowing and the oil-palm area at the Serdang Experiment Station has shown signs of dying out. This is thought to be due to a hard pan in the soil at a depth of about 4 ft. and it is probable that this diagnosis of the trouble is correct for recent information from the Belgian Congo indicates that the oil palm sends down its roots to considerable depths and that cultivations, when there is any serious limitation of root range, are tending to show decline and deterioration. Trials of oil palms by small-holders would appear to be warranted if only for the production of red palm oil as an addition to the normal diet of the people.

Arecanuts are another important crop in Malaya, an area of 61,700 acres being estimated as being under this crop. More than half the acreage is in Johore, where arecanuts form an important small-holders' crop. It is also a crop of importance to the small-holders in Kelantan and Trengganu. Exports in 1937 amounted to 83,200 tons, of which 53,100 tons came from the Netherland Indies and the balance (30,100 tons) was of local production. The exports are chiefly to India and Burma.

A collection of the several types of arecanuts has been made by the Department of Agriculture, but further work of selection for yield in this crop is desirable.

Another crop in which considerable interest has been taken in recent years is *derris*. The acreage under this crop has doubled in the past two years and further production is contemplated. It is being grown by Chinese small growers and also by estates. Its use as a catch crop in replanted rubber has been established, but it is also being grown as a pure crop. Some of the Malayan selections have a satisfactorily high rotenone content and although prices have fallen during the past year they are still regarded as being satisfactory. The future is, however, not certain if greatly increased quantities are produced, and it would appear that the time is not far distant when the markets will be more discriminating in regard to quality, especially if the research work now being undertaken enables more satisfactory tests of quality to be established as the result of standardization of the methods of analysis.

Imports of *coffee* for local consumption amount to nearly 6,000 tons annually and the tendency is to increase. Much of this could be produced locally if satisfactory methods of cultivation were evolved. The standard of coffee cultivation in Malaya is very low and the use of mulches, on the lines which have

proved so satisfactory in Uganda, have not yet been put to the test. The present area under coffee in Malaya could be more than doubled before the local demand would be met. An extension of this crop amongst small-holders is therefore possible as soon as satisfactory methods of cultivation have been established by experimental work by the Department of Agriculture.

Small experiments with *cacao* have also been started and it is also possible that this crop, if suitable cultivation methods are evolved, might be suitable for small-holders' production in selected areas.

Tobacco is grown on a small scale, especially as a rotation crop in vegetable gardens, and a further expansion of production to meet local demands would seem to be possible.

Agricultural Experiment Stations.

Reference has already been made in the section dealing with the padi industry to the provision which has been made for Experiment and Test Stations for that industry and also in the pineapple section to the two stations which have been established for dealing with cultural problems connected with that crop. The Department of Agriculture has developed the Central Experiment Station at Serdang and a number of agricultural stations distributed at various centres in the different States.

The *Central Experiment Station* at Serdang was commenced in 1920. This has an area of 1,537 acres, of which nearly 800 acres have been opened and planted up. At this Station a large number of crops have been planted for experimental tests, cultural operations and manurial problems have been studied, a small stock-farm established, and since 1931 a portion of the area has been devoted to the Agricultural School for instructional purposes.

Tea cultivation has been the subject of special study at Serdang, and a small model factory was erected. Similarly much of the earlier knowledge relating to oil-palm cultivation in Malaya was acquired at this Station. A small factory for the production of palm oil has also been established. The investigations of these two crops have provided much useful information which has been of value to Malaya. Similarly soil investigations, field trials with fertilizers and with cover crops have been most useful. The collections of economic crops are also extensive and the number of visitors to the Station and requests for information are considerable. The Station has usefully served Malayan agriculture and in recent years increased attention has been given by the staff attached to it to fodder grasses for stock and to fruit cultivation, including the provision of nursery stock of certified quality. The staff of the School of Agriculture has given special attention to poultry

keeping, and has established breeding flocks of high quality from which eggs and young chicks are widely distributed. The demands for stock from these flocks exceed the supply.

Numerous types of coffee have also been submitted to tests but the results have not come up to expectation, and I would suggest that this has been largely due to the cultural measures not having included sufficient attention to shade and to the use of soil mulches. Better results would, I anticipate, be secured if the shading of the soil and the maintenance of the soil organic matter had received greater attention. In an area planted with cacao, greater attention has been given to these important aspects of agriculture in the wet tropics and the general appearance of this crop was certainly promising. It was indeed better than I had expected.

Most of the fodder grasses which are used for feeding stock in Malaya have been introduced through the Experiment Station in Malaya and some useful grazing grasses have similarly been introduced. Fodder-grass cultivation to be successful must be heavily manured and it is quite clear that on the west side of Malaya, as in other parts of the wet tropics where there is no well-defined dry season, attempts at improvement in animal husbandry on grazing areas alone are doomed to disapointment, if not failure. Fodder additional to that which can be obtained from grazing is necessary if any improvement in stock is to be maintained and it is probable, as has been already demonstrated in Malaya itself, that successful dairying must depend upon the growing of fodder for the animals, and that the successful growing of this fodder depends upon liberal applications of organic manure to maintain soil fertility. It was suggested that *Centrosema pubescens* and *Indigofera endacaphylla*, in addition to the Guinea grass and Napier grass now generally grown, might be worthy of trial.

The work with arecanuts also attracted my attention, as also did the work with derris.

Trials with annual food crops have on the whole been disappointing. These results bear out experience in the wet tropics elsewhere, and the conclusion reached is that in the wet tropics the cultivation of orchard or tree crops offers greater possibilities of success than the cultivation of those annual crops such as maize, groundnuts, etc., which necessitate that the soil shall be uncovered during periods of the year, and thereby made liable to loss of fertility through leaching by reason of continued falls of rain. Under these conditions, it is only by the use of large quantities of farm-yard manure, composts or mulches that fertility can be maintained, and it is even doubtful if a system of agriculture which is economic can be satisfactorily evolved. Work on the preparation of composts has been started at

Serdang, but a greater amount of field investigational work in regard to their use is required and greater attention should, I am convinced, be given to the use of mulches.

District Agricultural Stations.

The Central Experiment Station at Serdang has served the plantation interests in Malaya well, and in 1931 it was decided to establish a series of small agricultural stations for providing for continuity of investigations into the problems of peasant agriculture. These stations were (1) to provide facilities for testing new crops, improved varieties and improved agricultural methods which had proved their value at the Experiment Stations of the Department, (2) to serve as centres of distribution of planting material and fruit trees, and (3) to act as centres for the dissemination of agricultural information.

A total of 25 stations, excluding those established for the investigation of pineapple problems and that which serves the Cameron Highlands, has been established. The majority of these stations have supplied a definite need and have been of value and assistance in connexion with the extension work of the Department of Agriculture amongst small-holders.

The crops which will thrive best in the locality have been demonstrated at these stations and they have proved useful centres from which improved planting material, particularly of fruit trees, can be distributed. On some stations which I visited tea had for example shown the best results, in others arecanuts, and in others cinnamon. Cacao at the Lipis station was promising, as also were pomelo and some of the oranges. Rambutans were also doing well at most stations. In some stations the areas devoted to sweet potatoes, cassava and groundnuts were satisfactory, but in others only poor crops were being raised.

Nursery work for the supply of fruit plants is carried out at most stations but in general a greater use of compost in connexion with nursery work is desirable.

Poultry is kept at most of the stations and the demand for eggs and young stock is good.

The time has now been reached when further consideration in regard to the work of these stations is desirable. It is necessary to determine, for example, the line of development which peasant agriculture is likely to take. There can be no doubt that in Malaya, as in several other tropical dependencies, the problems of dry-land agriculture for small-holders and peasants are the most pressing. Most of the work done at Serdang has been regarded mainly from the point of view of estate practice, and that of the Agricultural Stations has also not been looked at sufficiently from the point of view of the small-holder or peasant. Crops which are not attractive for estate production may well be suited to small-holder production, especially if they bring in a certain measure of return for the

labour expended upon them. The attractiveness of different crops cannot always be judged by the same measures as are applied in estate production and a peasant's views are apt to vary with his personal circumstances and the size of his holdings. In the western side of Malaya, if not indeed throughout the whole country, permanent tree or orchard crops offer the best chances of success as money crops, and their cultivation should be combined with the use of mulches or composts or with animal manures if soil fertility is to be maintained. This may necessitate the introduction of animal husbandry as part of the peasants agricultural systems and the Agricultural Stations of the Department of Agriculture should endeavour to ascertain how this can be most satisfactorily achieved. Small-holders in Malaya have their holdings of rubber and their padi sawas. In some areas an owner may have an area of each but in others this is not possible. Coconuts and arecanuts are also important cultures. Kampongs are thickly covered with plants of various kinds including numbers of fruit trees, but Kampong holdings are not producing to anything approaching their capacity. Much greater production should be possible, if the use of composts, mulches or animal manures were more general, and there is little doubt that greater attention could be given in the Kampongs to the production of fruit of better quality.

The Adviser on Agriculture in Malaya, who has recently given considerable thought to this matter, has suggested that oil palms, cacao and coffee should offer possibilities to small-holders. There is little doubt that an extension of coffee production to meet the local needs is justified and that trials of oil palms—with the use of small presses recently found to be satisfactory in West Africa—are worthy of trial. Tests of cacao in selected areas would also be justified provided that care is taken to select types which are known not to be self-incompatible. Similarly it is also clear that the possibilities of mixed farming whereby animal husbandry is introduced into the peasant agriculture of the country should be subjected to careful test.

This problem of suitable methods of husbandry for the non-irrigated lands in the wet tropics still faces agricultural workers and a satisfactory solution has yet to be found. Some progress has been made in Java and Nigeria by the use of green manuring, but this system is not applicable on all soils or under all circumstances. Mixed farming offers better possibilities and the use of mulches, which has been found so satisfactory in the West Indies and Uganda, or of composts, suggest themselves.

It is only by submitting these methods to the test that progress will be made and it therefore seems desirable that steps should now be taken to examine the results which have been obtained at the several agricultural stations and determine the lines on which they can best be calculated to serve in the future the

interests of the small-holders of the areas in which they are located. In regard to the several stations in Kelantan, the following conclusions were reached in the discussions which took place with the British Adviser in that State:—

Kota Bharu.—Observations were needed on the drainage of the dry land crop area, and heavy mulching of the permanent crops, particularly during the dry season, should be practised. Fruit and poultry work should be centralized for the present at this station, and some development of this line of work might be undertaken at the Melor Agricultural Station.

Bachok.—The light sandy soil at this station is not well suited either to wet or dry padi. It was suggested that trials should be made with cashew, oil palms, fruits and derris. Groundnuts, chillies and tomatoes might be grown here as annual crops and tobacco given a trial. The fertility of this type of land will not be maintained without manuring and the growing of an area of fodder crops for the stall-feeding of cattle on the station should be undertaken.

Pasir Mas.—This station should be developed as a padi test station and a trial given to the manuring of the fields with the green leaves cut from shrubs which surround the padi areas in the district.

Melor.—This station should be used to test the possibilities of mixed farming. The future improvement of Kelantan agriculture must lie in the keeping of cattle under farm conditions, the feeding of them with grown fodders and the making of farm-yard manure and composts. Similarly any real development and improvement of the cattle industry depends upon the growing of fodder and the satisfactory housing of the stock. In addition to grass fodders, trials should be made with *Canna edulis* which has been found to be so useful as a stock feed in parts of East Africa, *Centrosema pubescens* and *Indigofera endacaphylla*. The planting of Jak (*Artocarpus integrifolia*) might also be considered, as there is a growing need for timber in this district, and the jak fruit can be used as food for man and also for stock. The leaves of the jak may in periods of fodder scarcity also be fed to stock.

These notes relating to the Kelantan stations are illustrative of the kind of review which is required in regard to all the smaller agricultural stations which have been established for the needs of peasant agriculture. Discussions took place with agricultural officers at a number of these stations and they propose to give careful consideration as to the necessary steps which should be taken in the next stage of their development.

Agricultural Education.

Vocational training in Agriculture is provided at the School of Agriculture which was opened at Serdang in 1931 and the Farm School, Malacca, opened in 1935. Teachers are trained in nature study, school garden work and elementary agriculture at the Sultan Idris Training College at Tanjong Malim and elementary nature study and school garden work forms part of the education given at vernacular elementary schools in the Straits Settlements and in the Federated Malay States.

The *School of Agriculture* at Serdang provides for a major course in English extending over two years and a minor course, normally conducted in Malay, of one year's duration. Emphasis is given to practical training at the school and on the Central Experiment Station. The syllabus for the two-year course includes science subjects, mathematics, crop husbandry, plant pathology, animal and poultry husbandry, estate sanitation and elementary surveying and students who complete the course secure employment in the Department of Agriculture with the Rubber Research Institute or on estates. The one-year course is not so advanced and students who complete it are employed in junior subordinate positions in the Department of Agriculture or return to their families' small-holdings. The school is residential and a number of major and minor scholarships to it are provided by the Malayan and Straits Settlements Governments. There are normally about 25 students admitted each year, and half of these are scholarship holders.

The instruction at the school is good, but the courses suffer from one serious drawback. Neither coconuts, pineapples nor padi is grown at Serdang and practical instruction in these crops cannot therefore be given at the school. Some efforts are made to overcome this drawback by excursions to other Experiment Stations which deal with these crops, but in view of the importance of rice in particular to Malaya I would recommend that arrangements be made to extend the courses in order that practical instruction may be provided in rice cultivation. The Rice Experiment Station at Malacca would probably afford the best facilities for this training. So much of the work of the Department of Agriculture is concerned with the improvement of padi cultivation that all officers of the Department should receive definite instruction in and practical experience with padi production. Under existing circumstances officers are attached after appointment to padi test stations but this instruction should, in my view, form an integral part of the courses of the School of Agriculture.

Refresher courses are also provided at the school for officers of the Departments of Agriculture and Co-operation and for Government headmen.

The *Farm School,* Malacca, is non-residential and is situated at the Sungei Udang Agricultural Station. It gives a one year's course of instruction in the vernacular and is essentially practical. The object of the school was to provide a suitable training for boys who would ultimately work their own or their families' small-holdings. Proposals for the establishment of other Farm Schools of the same type were under consideration, but it has been decided to postpone consideration of these proposals for the time being. Investigations of the circumstances of the students who passed out of the Malacca Farm School showed that only one-third of them returned to work their families' homesteads and these invariably came from rural areas some distance from Malacca town. In future, it has been decided that applications only from rural districts should be entertained, that the students should be housed in small houses of the rural Malay type and that the occupants of any house shall be held responsible for the cultivation of small areas of land surrounding that house. In this way it is hoped to create conditions akin to those of the Malayan small-holder and to provide practical agricultural training under conditions which will be familiar. I indicated when in Malaya that I was strongly in favour of the changes which were proposed and they have since been put into effect.

The results of the trial of this system at the Malacca Farm School will be watched with interest and if it is successful consideration will be given to the establishment of farm schools on this model in other States.

At Ayer Itam Station in Penang a Farm School for the sons of small Chinese agriculturists was started during 1937.

The *Sultan Idris Training School.*—A visit was paid to this school at Tanjong Malim. Here pupil teachers are trained and during their training receive instruction in elementary agriculture and carry out a certain amount of practical school-garden work. Much greater attention should, I feel, be given to the agricultural section of the syllabus and provision made for an improvement in the form of instruction given. The practical work, judging from the school plots and its school-garden work, left very much to be desired. Insufficient attention was clearly being given to the preparation of composts, the use of mulches and the importance which must be attached to the maintenance of soil fertility. If this Training School is the main centre for the training of teachers for Malayan vernacular schools and if it is the intention of the Education Department that the rural bias in the teaching in vernacular schools should be something real, great improvements in the agricultural instruction and training given to the teachers who attend training courses are necessary.

Co-operation.

Co-operative thrift societies amongst urban communities have made marked progress but there is a certain lack of opportunities for the investment of funds. Co-operative societies amongst Tamil labour on estates have also been successful and are expanding. Rural societies have made slow progress and all these societies are required to work with funds which have been collected from members. There is very limited scope for the development of padi banks but the system of seasonal advances to padi growers is beginning to be popular and is useful. A co-operative egg society has done well, but efforts to establish co-operative copra societies have not been successful. Similarly co-operative rubber societies for the preparation of smoked sheet have not shown signs of development.

Consideration is now being given to the development of co-operative medical work in the kampongs and it is thought that there should be an opportunity in this connexion for much useful work.

The Cameron Highlands.

Discussions with the Cameron Highlands Association related to the further development of this elevated portion of the Malay peninsula. Tea has been proved as a crop for the Highlands but its extension depends upon economic considerations and upon the area which it can be agreed can be assigned to Malaya under the International Tea Regulation agreement. Citrus growing has been tried and is fairly promising, whilst the cultivation of *Aleurites montana*, mixed fruits and vegetables have also been undertaken. The possibility of *Aleurites montana* being profitable has still to be proved and careful selection of mother trees in this crop for supplies of planting material has been shown in Java and Nyasaland to be essential. The production of vegetables is expanding and could be further increased if pest control, possibly with derris powder, were effective. The cultivation of flowers is being undertaken and more could be done in this direction. Neither of these two enterprises is, however, likely to be successful without the provision of adequate supplies of farm-yard manures as soil fertility is unlikely to be maintained without its use. Pig-keeping has proved to be profitable to one resident and poultry-keeping is being undertaken by others.

Of the fruits growing in the Cameron Highlands, the most promising appeared to be grape-fruit, some kinds of oranges, lemons, cherimoya, loquats, peaches and tree tomatoes.

The Department of Agriculture at its Experiment Station has devoted attention during the past year to investigating the possibilities of flowers and vegetables and proposes to open up a new area which has been acquired to test a wide range of fruits.

Trials plots of *Cinchona ledgeriana* are also to be established in five different areas as the earlier tests with this species have been promising.

In general, the land slopes in the Cameron Highlands are steep and erosion may be a difficulty if adequate precautions are not taken. The use of cover crops or growths of soft weeds offer the greatest possibilities against erosion in the Cameron Highlands as the land slides seriously if any weight of water accumulates in drains or silt pits. Fortunately the falls of rain are not very heavy and with careful management serious soil erosion may be avoided. The more gentle slopes should however be selected for development, and it is possible that there are areas which are less steep in those parts which have not yet been roaded. For vegetable and flower cultivation only level land should be selected or steps taken to make satisfactory terraces.

The demands in Singapore for fruit and vegetables and the large imports from the Netherlands Indies and China indicate that producers should find ready markets, if the costs of production are reasonable and satisfactory cultural methods are adopted. As stated in an earlier section, the export of vegetables from the Cameron Highlands amounted to 387 tons in 1937.

The recent developments in the work of the Department of Agriculture should be of value to the residents in the Highlands and should indicate the directions in which further commercial enterprises can be undertaken.

Transport is the main difficulty at present but further road development can hardly be recommended until the economic prospects of the area have been more fully ascertained.

Rejuvenation of Mining Lands.

Large areas of land which has been mined for tin are left in an unproductive state. It is now obligatory on those who hold dredging licences to slime lands which have been worked before they leave them. The lands are thereby left in a levelled state with a layer of fine silt on the surface. This silt is generally devoid of organic matter and it takes years, in some instances, before a satisfactory growth of vegetation occurs on it and much longer before the land is fit for agricultural purposes. The total areas of such lands in Malaya are considerable and many of these areas are located at centres where there is some pressure for land for agricultural industry.

The British Resident at Ipoh in Perak asked me as to the measures which could be adopted to bring these lands more rapidly into beneficial occupation.

It is obvious that these lands can only be rejuvenated if the organic content of their soils is increased. This should be possible, on a limited scale, by a system of intensive market

gardening where large quantities of organic and animal manures were employed but on a larger scale it would be necessary to hasten their being covered with vegetation by the planting or sowing of seeds of shrubs or forest growth which would provide periodically a good leaf fall. The Forest Department might be able to suggest suitable shrubs or herbaceous weeds which could be utilized for this purpose, but it is possible that the *Vitex* which has been used successfully for the suppression of lalang might be worthy of a trial and judging from the readiness and vigour with which cinnamon grows on all classes of soil in Malaya it also should be considered. Cinnamon if it finds conditions reasonably suitable rapidly forms a good cover and its leaf fall over the years is fairly considerable.

Experimental tests would certainly be worth while, for if this mining land could be brought back into use for agricultural purposes within 15 to 20 years from the time it has been mined it would be an economic proposition.

I visited one area where nature had been permitted to provide the shrub growth and where the areas between this growth were being permitted to be used for grazing purposes. Rejuvenation by this means is slow and uncertain and it certainly seems that by a judicious planting of selected shrubbery plants soon after mining operations have ceased the biological processes necessary for land rejuvenation could be hastened without undue expense.

Summary of Conclusions.

1. Malayan soils are generally of low fertility and it has been fortunate that a tree crop such as rubber has been found suitable for cultivation on the quartzite soils.

2. As far as rubber is concerned, it is concluded that the Rubber Research Institute is doing most valuable work for the industry. Further attention should be given both by the Institute and by rubber-growing interests to the establishment of cover crops as a check to soil erosion. In old rubber this is often difficult but experience elsewhere indicates that it should not be impossible if use is made of phosphatic manures. Further efforts in this direction are clearly desirable, particularly as the value of phosphatic manuring in rubber in Malaya has been proved. Cover crops are now freely used in young rubber in replanted or newly-planted areas, but there is evidence that growth is somewhat retarded in the early years by reason of root competition. It has yet to be determined whether this effect is continuous and there can be little doubt that for the maintenance of soil fertility and as a check to erosion the use of cover crops is desirable. It is suggested that trials be made with lopping covers grown in young rubber and using these loppings as a mulch around the young rubber plants.

3. The importance of continuing without interruption plant breeding work with rubber is considered to be of importance.

4. Greater use of compost in the nurseries where rubber bud-wood is being produced should be beneficial.

5. The small-holders' advisory service of the Rubber Research Institute is doing useful work and it is suggested that type plans of smoke-cabinets should be prepared for issue to interested applicants. It is also suggested that middlemen purchasers of wet rubber from small-holders should be encouraged to erect smoke-houses for the production of smoked sheet and consideration given to the possibility of licences to buyers being made conditional, after a due period of time, upon the erection of smoke-houses of approved design.

6. Malaya produces only about 40 per cent. of its rice requirements, and the measures taken in 1932 to improve this position should be continued without abatement. The work of the Drainage and Irrigation Department and of the Department of Agriculture in connexion with the rice industry has been productive of considerable advances. There is a need for a greater production of rice in the State of Johore and in Kelantan progress would be hastened if a Drainage and Irrigation Engineer were appointed to and stationed in that State.

7. The work of the Department of Agriculture for the padi industry is organized on sound lines, and considerable progress has been made, particularly in the selection, testing and distribution of pure-line strains of padi. A review of the manurial trials undertaken at the padi stations of the Department of Agriculture is, however, proposed and further work in the study of the agricultural aspects of cultivation is foreshadowed. A greater measure of flexibility in the work of padi experiment and test stations is also suggested. Reference is made to some of the very useful indigenous implements used in the padi industry of Malaya. Some of these are well worthy of trial in other parts of the Colonial Empire.

8. It is possible that the development of mango-growing in the padi areas in Kedah and Kelantan should be practicable. Such cultivations by providing a money-crop would help to improve the economic conditions of the small-holders.

9. Further scientific investigations in connexion with par-boiled rice under present-day methods of production in the larger rice mills are suggested.

10. The Department of Agriculture has done very good work by its copra investigations, and the manufacture of copra has greatly improved in recent years. To assist small-holders growing coconuts, it is proposed that the Department of Agriculture

should prepare printed type plans of the copra-drying kilns which have been successfully evolved. Middlemen purchasers of coconuts for conversion into copra should be encouraged to erect kilns of the approved types and if necessary a condition to this effect might be introduced into buyers' licences.

11. If plant-breeding work for coconuts is to be continued, a new experiment station on land suited to the cultivation of this crop will be required.

12. The tea industry, with assistance from the Department of Agriculture, should endeavour to make in Malaya green tea, in order that imports of this commodity may be replaced by the products of local production.

13. The improvement of the pineapple industry has received attention by the Department of Agriculture and as the result of its efforts considerable improvements have been effected in pine-apple factories. Many of them have been rebuilt and in all sanitary conditions have been greatly improved. Grading of produce is now accepted as being desirable and steps are being taken by the industry to improve marketing organization. The fairly widespread occurrence of mealy bug wilt of pineapples is, however, recorded and this has been confirmed by the Entomologist to the Hawaiian Pineapple Experiment Station. Control by spraying should be possible but the trial of predators is suggested. Further attention will have to be given to the maintenance of soil fertility if pineapples are to continue to be grown successfully in mono-culture in Malaya.

14. The problem of maintaining soil fertility on the high lands is the major agricultural problem in Malaya, and its solution will be of the greatest benefit to agriculturists generally. The small-holders require assistance in developing increased pro-ductivity of their kampong lands and it is recommended that the work of the district agricultural stations should be reconsidered and steps taken to ascertain by experiment the directions in which small-holders' agriculture can be profitably advanced. A number of suggestions are made for consideration.

15. Increased attention can undoubtedly be given to the development of fruit cultivation and it is suggested that a new post of Horticulturist or Fruit Specialist should be created in the Department of Agriculture with this object in view.

16. Agricultural Education is briefly reviewed and it is sug-gested that there is need for the provision of training in padi, coconut and pineapple cultivation in addition to that given in the present courses. Agreement is expressed with the remodel-ling of the Farm School, Malacca, and it is indicated that the improvement of the agricultural training provided at the Sultan Idris Training School is most desirable.

17. The problem of the rejuvenation of lands after they have been mined is referred to, and suggestions made in respect of planted shrub or forest cover in order to provide a more rapid accession of organic matter than is customary when these lands are left to Nature.

18. Frequent references are made to the necessity for attempts at the introduction of mixed farming into peasant agriculture in order that soil fertility may be maintained. The value of the use of mulches is also referred to and further trials with composts would seem to be indicated. The subject of animal husbandry has not, however, been dealt with as this matter is under separate consideration by the Governments of Malaya and the Secretary of State.

THE NETHERLAND INDIES.

The visit to Java and Sumatra was made with the object of studying at first hand the agricultural methods in vogue in those countries and the organizations which have been built up for research and advisory services. Attention was also given to such questions as the provision of credit facilities, agricultural education and rural reconstruction. The programme was drawn up for me by Dr. Beumée, Director of the General Agricultural Experiment Station, in consultation with His Majesty's Consul-General at Batavia, Mr. H. Fitzmaurice, C.M.G. It included discussions with Mr. C. van den Bussche, Vice-President of the Raad, who was acting as Deputy for the Governor-General during the latter's absence from Java on tour, Mr. L. G. C. van der Hoek, the Governor for West Java, Mr. van Mook, Director of the Department of Economic Affairs, Dr. Ir. F. Kramer, President of the General Agricultural Syndicate, Dr. Beumée, Director of the General Agricultural Experiment Station, Dr. Th. G. E. Hoedt, Director of the Proefstation, West Java, Dr. G. M. Kraay, Chief for Rubber Research, the Director of the Buitenzorg Botanic Gardens, Dr. G. A. van der Horst, Chief of the Agricultural Extension Service, Dr. G. A. de Mol, Chief of the Agricultural Education Service, Dr. Ir. J. Thos. White, Chief of the Soil Institute, Dr. Ir. A. Wulff, Chief of the Agricultural Institute, Dr. P. van der Goot, Chief of the Institute for Plant Diseases and numerous other scientific officers at Buitenzorg, Dr. G. Terra, Chief of the Horticultural Division, Dr. Coolhaas, Director, and the staff of the Malang Experiment Station, Dr. Ir. H. A. Middelburg and the staff of the Klaten Tobacco Experiment Station, the Acting Director and staff of the Passoeroean Sugar Experiment Station, Mr. M. van Roggen, Superintendent of the Government Cinchona Plantation, Tjinjiroen, Dr. A. de Angremond, Director, and the staff of the A.V.R.O.S. Proefstation in Sumatra, Inspectors J. Gotz van der Vet, Kowankof and Wirte of the Agricultural Extension Service and others too numerous to mention individually.

Mr. H. P. Adams, Chief Representative of the Anglo-Dutch Company, and the senior members of his staff showed me over the estates of that company during the three days that I spent with them; it is difficult to express my thanks for their assistance and hospitality. Similarly, much valuable assistance and help was given to me by Mr. Daniel and Mr. Thompson, representatives of Messrs. Harrisons and Crosfield, Ltd., at Batavia and Medan respectively, and by Dr. K. W. Müller, Scientific Adviser to the estates in that Company's agency. Dr. Hydrick of the Rockefeller Foundation and Dr. de Buys Kops also showed me the work of the Poerworkerto Health Unit.

To all I wish to convey my grateful thanks for the assistance given to me and in particular I would wish to thank the Consul-General, Mr. H. Fitzmaurice, most sincerely for all the help

and assistance which was given to me during the whole of my time in the Netherland Indies.

It would be impossible to describe within a reasonable compass the observations made in Java and Sumatra and I propose, in consequence, to limit myself to those items which would appear to be of the greatest interest to agriculturists in the Colonial Empire at the present time. References have already been made in the Malayan section to this Report to rubber in the Netherland East Indies and certain comparisons made. It is unnecessary to give further details here, particularly as a detailed account of the position has been given in the report of Mr. R. K. S. Murray, Botanist and Mycologist to the Ceylon Rubber Research Scheme, after his visit in 1937, nor is it necessary to refer in any great detail to tea in view of the report to the Ceylon Tea Research Institute by Mr. James Forbes and Dr. R. V. Norris after their visit to Java in 1935. Reference to tea will be limited to the work which has been done in Java in connexion with the improvement of plant material.

Attention to Soil Problems.

The attention which is now being devoted throughout the world to soil conservation and to the control of soil erosion has naturally led to an examination of the position in the Netherland Indies.

In Java, the measures taken to conserve soil and preserve its fertility have already reached a high standard. These measures have been necessitated by the density of the population and the people have been favoured by the natural richness of many of the island's soils. The method employed in Java is the extensive use of irrigated terraces supplemented with a reservation of forests on those mountain slopes from which the irrigation waters are secured. To maintain fertility considerable use is made of shade trees and green manures.

It has been realized that the conservation of the forests on the higher slopes of the mountains is of prime importance and of the forest area which amounts to about 3 million hectares, or slightly less than one-quarter of the total area of the island, some 2,600,000 hectares have been demarcated as Reserved Forests and placed under the care of the Forest Service. Of the total area of $7\frac{3}{4}$ million hectares occupied by small-holders in Java, $3\frac{1}{4}$ million hectares were terraced "sawahs." Many of these are irrigated by primitive means only but the majority of the irrigated levelled lands receive their water supplies from an elaborate system of dams in the rivers and reservoirs built and maintained by the Irrigation Service. One cannot help being impressed by the work which has been done and the care which is given to the nature of the water used and to the organization of its control. Certain waters containing constituents

harmful to plant life are diverted and permitted to run to waste, whilst others containing silt or soil fertilizing agents are carefully diverted into and used by the irrigation system. It is claimed, with a certain measure of justification, that the soil fertility of many of the rice growing areas in certain parts of Java is maintained as much by the deposits which they receive from the irrigation waters as from the agricultural methods employed.

In the Outer Provinces (Sumatra, Borneo, Celebes, etc.) the position is very different. The soils are not as fertile as those of Java and the density of their population is about one-tenth of the density of the population of that island. Shifting cultivation is the rule of 90 per cent. of the cultivated area and it is estimated that between 4 and 5 million hectares are yearly subjected to this form of cultivation. A certain proportion of it becomes covered every year with lalang grass (*Imperata arundinacea*) and thereby may be rendered largely useless for further cultivation by small-holders. The area of the forest-covered lands in the Outer Provinces amounts to 120 million hectares out of a total of 177 million hectares but only 6 per cent. of the total area has so far been declared as Reserved Forest.

A more active forest policy in the Outer Provinces is contemplated and attention is also being given to the development of irrigation schemes. The Minister of the Colonies stated in the Second Chamber of Representatives at The Hague in March, 1938, that the conservation of the fertility of the soil in the Outer Provinces of the Netherland Indies was receiving the fullest attention of the Government, which would do all in its power to put an end to the present neglect in this respect.

Estates also pay particular attention to soil conservation. These cover about 600,000 hectares in Java and 550,000 hectares in the Outer Provinces. The use of ground cover (whether cover crops or selected soft weeds) is general, contour drains and silt pits are commonly employed and in certain localities platform terraces are frequently to be seen.

It may be accepted that, although the position in the Outer Provinces is not really satisfactory, there has been greater attention given in the Netherland Indies to soil conservation and the maintenance of soil fertility than has been the case in the past in the British Eastern possessions. This is particularly the case in estate agriculture and may be due, in part, to the fact that a very fair proportion of the managers and assistants on estates in Java and Sumatra have received the full agricultural training, with specialization in tropical agriculture, provided at the Agricultural College at Wageningen in Holland prior to their appointment to positions in the East. The Proefstations also include sections which deal with the special soil problems of the industries for which the stations work and I was impressed by

the general soil work and soil mapping being done by the Soil Institute at Buitenzorg and the soil investigational work being carried on for the sugar industry at Passoeroean, for the Vorstenlanden tobacco industry at Klaten and for the rubber industry at Medan, Sumatra.

The work of the Soil Institute at Buitenzorg also includes the analysis of irrigation waters for the Irrigation Service, in order that waters containing good silts may be used in the irrigation projects and those containing poor or harmful silts diverted into rivers and streams not tapped for irrigation purposes.

Experiment Stations.

Agriculture in the Netherland Indies has been well served by its Experiment Stations. Work for peasant agriculture has been centred at the General Agricultural Experiment Station, Buitenzorg, which is maintained by Government funds. It has also carried out important work for estate agriculture, but this work has been increasingly transferred, whenever practicable, to the experiment stations maintained by crop interests. Up to 1932, these experiment stations for estate crops were under the control and direction of the Algemeen Landbouw Syndicaat, which is the principal planting organization in Java, the South and West Sumatra Syndicaat and the Rubber (A.V.R.O.S.) and Tobacco Syndicaats in the East Coast of Sumatra. These experiment stations were financed by a voluntary acreage cess, but during the depression the various estate interests were compelled to seek Government assistance with the result that organizations were created by Government Ordinance and no estate owner may despatch produce from the estate without first obtaining a transport licence, calculated on the crop of the previous year, for appropriation to the various Crisis Centrales. The control of Crop Experiment Stations, with the exception of tobacco, is now vested in the Central Association of Experiment Stations, which is charged with the maintenance of research and investigational work at the experimental stations and the provision of advisory services for the crop interests concerned.

In this way Experiment Station work and Advisory Services are maintained for the rubber, tea, coffee, cacao, cinchone and sugar industries in the Netherland Indies.

Visits were paid to the West Java Rubber and Tea Experiment Station at Buitenzorg, the Coffee and Rubber Experiment Station at Malang, the Sugar Experiment Station at Passoeroean, the Cinchona Experiment Station at Tjinjiroean, the Tea Experiment Station at PasirJunghuhn, the Tobacco Experiment Station at Klaten and the A.V.R.O.S. Rubber Experiment Station at Medan in East Sumatra.

The Government General Agriculture Experiment Station at Buitenzorg forms a section of the Department of Economic Affairs which is the Administrative Department at Batavia which deals with tariff matters generally, restriction schemes, forests, agriculture, animal husbandry, agricultural credit, and agricultural instruction and education.

The station is divided into five main sections together with one sub-section for coconut investigations at the Coconut Experiment Station at Menado in the Celebes. The various main sections are as follows:—

1. *Laboratory division.* This division is devoted to botanical research. At the time of my visit the work being done was mainly of a physiological character, relating to the yellowing or reddening of paddy in certain areas where growth was unsatisfactory. This condition of the paddy plant, associated, as is the case generally, with shortening of the internodes, is connected with potash deficiency in the soils. Remedial measures including the application of potash fertilizers are under test.

The variability in the flowering and fruiting of *Aleurites montana* is also another piece of research being started by this division and one scientist is to be detailed for a period of five years to select out promising mother trees for this crop and work out the most satisfactory methods for multiplication.

A considerable amount of work has also been done in connexion with the preparation of cultures for the inoculation of seeds of soya bean before sowing.

2. *Institute for Plant Diseases.* This Institute is divided into two divisions—the one dealing with phytopathological problems and the second dealing with entomological matters. Full co-operation is maintained with the plant breeders, and many strains of crop plants resistant to pests and diseases have been evolved.

The most striking work in this connexion has been the strains of groundnut resistant to slime disease (*Bacterium solonaciarum*). Swartz No. 21 is the most popular resistant variety and is now largely grown throughout Java. The slime disease is very prevalent in the Netherland Indies and no groundnuts are now permitted to be grown on lands used for the cultivation of tobacco. In the Sumatra tobacco-growing areas the disease is controlled by growing a crop of tobacco only once in seven years on the same land and following this with a heavy crop of *Mimosa invisa*, which is ploughed in, before the land is thrown out into bush growth for a further five years. It is thought that the bacteriological flora which multiplies during the decomposition of the green dressing has a definite effect upon the bacterium responsible for the slime disease.

Another important investigation has lead to the selection in South Sumatra of a pepper variety which is resistant to nematode attack.

Other work of the section includes the biological control of insect pests—a method which has been used with success in connexion with some pests, especially in the Outer Provinces. The rhinoceros beetle (*Oryctes rhinoceros*) of coconuts is still serious in certain areas in the Outer Provinces, but so far its biological control has not yet been effected. *Scolia oryctophaga* has recently been introduced from Mauritius and traps of the green muscardine fungus *Metarhizium* grown in cultures in the laboratory are being employed with some success.

Astonishingly successful control of *Armillaria* attacking orange groves in East Java has been effected by means of applications of sulphur. I was able subsequently to visit work at Batoe near Malang where the Provincial Government had undertaken a three-year campaign of treatment of this disease. All the soil in the orange groves of the affected area is dug to a depth of 1 foot and all the main roots of the trees bared. Dead roots are dug out and burned, sulphur applications at the rate of 1 kilo per tree are made on the exposed roots—especially those where rhizomorphs are visible—and finally the soil, mixed with sulphur at the rate of 1 kilo per tree, is thrown back over the roots. The treatment is most effective and the district, which depends upon the orange as its money crop, has been saved from disaster.

Cassava mosaic is stated by the entomologists to exist, but I did not see any examples of this disease. A watch is being kept for the disease because of the importance of the cassava crop in Java as a food as well as an economic crop. Two types of cassava introduced in recent years from Brazil are the most popular at the present, being high yielders and productive of tubers of good quality. Cross breeding with *Manihot Glaziovi* has been successful and some interesting interspecific crosses have been raised.

Potato blight (*Phytophthora infestans*) became epidemic in the higher altitudes in Sumatra in 1934 and a year later in Java. Considerable losses have been incurred and the raising of resistant strains suited to cultivation under Netherland Indies conditions has been started. Large collections of types of potato have been obtained from all over the world and a sample collection of the Russian importations from South America has also been obtained for breeding and selection work.

Attempts are also being made at one of the Malang Fruit Stations to breed types of oranges and mandarins immune to the Phytophthora gumming disease of citrus. A large collection of material has been produced and it is now being tested for resistance to this disease.

Detailed work has also been started in connexion with the insecticidal value of derris. The crop is now being extensively grown in Java and a small factory for the production of derris powder for local use in the Netherland Indies has been started. The cabbage caterpillar is used as the control insect in connexion with the biological tests made to assess insecticidal values. All growers of cabbages and cauliflowers upcountry in Java now use derris powder regularly as the control of the cabbage caterpillar, which if left unchecked causes considerable damage. Exports of derris are made in the form of dried roots.

3. *Soil Institute.*—The work of this section is divided into three divisions for (*a*) soil mapping, (*b*) soil research and (*c*) irrigation waters. The soils department is responsible for all soil investigations and research of a general character and for manurial experiments. It is also responsible for advice on soil problems to the Extension Service.

The soils in Java, as may be imagined, are very variable owing to volcanic action, but they are generally low in phosphates and some of them also are poor in potash. Considerable progress has been made with the mapping of soils in Java and a beginning has been made with the soils found in the Outer Provinces—particularly Sumatra and Celebes.

4. *Horticultural section.*—This is only a small division of comparatively recent creation. It has been formed to undertake investigations in regard to fruit cultivations and has under its supervision the Pasir Minggoe Fruit Station near Batavia and the two Fruit Stations at Malang. The former station deals with low country fruits, whilst the two stations at Malang concentrate on citrus, as the land near the limestone hills of the northern range is very suited to oranges and mandarins.

At Pasir Minggoe, the main work is in connexion with durian, rambuttan and citrus. Areas of the station are devoted to (1) a collection of exotics, (2) a collection of indigenous varieties from all over Java, (3) variety trials, (4) stock trials and (5) manurial trials. A large number of varieties have been collected together and are being grown, of which a few are of outstanding merit. I was particularly impressed by the following:—siem mandarin for areas with a fair rainfall, Poerten orange, pandan pomelo and simatjan rambuttan. The stocks used for citrus are the Japanese citron and rough lemon. Japanese citron is preferred as a stock for districts which have a long dry season, as it has a deep-rooting system and it is possibly a slightly better stock for mandarins than for the ordinary orange. Success has not been obtained with sour orange as a stock, but in recent years a type of sour orange obtained from Peradeniya, Ceylon, has been found to be most promising for stock purposes at the Malang Stations. It differs from sour orange material secured from California and its leaf

growth shows certain variations. Pomelo has been used on occasion as a stock for grapefruit but has been found to be incompatible for oranges and mandarins.

The nursery work receives most careful attention. All nursery beds are heavily manured with stable manure or compost, and 40,000 budded plants are issued from Pasir Minggoe annually and 20,000 from the Malang stations. The stock plants raised from seed of Japanese citron can readily be grouped into those of assexual or vegetative origin (70 per cent.) and those of sexual origin. The latter show a much more cramped growth in the early stages of growth and are all discarded. Only the most vigorous growing seedlings are used for stock purposes and a modified " forket " method of budding is adopted.

Citrus scab occurs in the nurseries but it is controlled successfully by shading the nursery beds in the early periods with a temporary cover of white cheese cloth. *Sesbania cajaniflora* is used as the permanent tree shade for the nursery beds.

All fruit plants at Pasir Minggoe profit from a general manuring during the first three years after they are planted out and their general appearance has greatly improved since the grass and leguminous mixed cover, which grows between the rows of plants, has been cut regularly and applied as mulch to the rings kept free of weeds immediately around the trees.

The Station issues a priced catalogue of budded plants available for sale and this includes not only 7 varieties of durian, 8 rambuttan, 16 mangoes, 10 pomelo, 7 grapefruit, 12 oranges, 7 mandarins, 4 avocado pears, but numerous other selected varieties of tropical fruits.

Considerable advances have been made since the horticultural division was started and there is little doubt that similar progress could be made in Malaya if attention by an officer specially deputed for this purpose were given to fruit cultivation generally and to the improvement of the locally preferred tropical fruits in particular.

5. *Agricultural Institute.*—This is the largest section and is divided into four divisions as follows:—

(*a*) *Agricultural division for annual crops.*—This division is responsible for variety trials, manuring and green-manuring trials, improved implements and general seed distribution. It has an experimental and seed farm under its direct supervision.

(*b*) *Selection division for annual crops.*—This division is responsible for the improvement by selection and plant breeding of annual crops such as groundnuts, rice, maize, cassava, sweet potatoes, soya beans, etc. It has under its care the central selection station " Tjiikeumeuh " at Buitenzorg, three subsidiary selection stations on old laterite soils,

Badam tuff soils and calcareous soils, respectively, and a special selection station in East Java for maize and soya beans.

(*c*) *Agricultural division for perennial crops.*—This division is responsible for improving the yield of coconuts, kapok and other permanent crops—selection work is included. It is responsible for the Economic Garden at Buitenzorg, the Experiment Garden " Tjibinong " and the special Experiment and Seed Garden " Moektibardjo " for kapok in Central Java.

(*d*) *The Statistical division,* which is responsible for statistical methods for field experiments and the influence of climatic factors on the yields of crops.

Reference has already been made to the successful work which has been done in collaboration with the Plant Diseases Institute in connexion with groundnuts. The erect types are favoured in Java and Swartz No. 21 is the most popular of the types resistant to slime disease. Work with the selection and breeding of cassava is well advanced and all the manurial tests with cassava show that green manuring, with or without phosphates, is the most advantageous treatment under Java conditions. The growth of cassava after a previous crop of green manure (bush covers such as *Crotolaria anagrioides* are generally used) is always more luxuriant than when no green manure is grown and the yields of roots are much higher.

The work with soya bean has also been outstanding. Non-shattering types have been isolated and bred, and types with differing periods of maturity have also been evolved in order to overcome the difficulties experienced from the *Agromisa* pest. Soya beans are now largely grown in Java and a former import of 100,000 tons per annum is now replaced by local production. The soya grows better in East Java where there is a marked dry season than in West Java, and it is grown on high lands as well as in the sawas after the padi crops have been harvested. In the latter case the seed is sown just before the harvesting of padi commences.

Considerable work has been done in respect of padi. This work has included pure-line selection, hybridization and manurial trials. The increases in yields from pure-line selection work have not come up to expectations. This is undoubtedly due to the care which this crop has received from the cultivators over many generations. There has been going on for years, if not for centuries, a natural selection by the growers themselves. Padi fields in Java show that this careful selection of seed by the growers has resulted in crops which are practically pure to type. In consequence it is but natural that pure-line selection work has not given the results which have been obtained in India, Malaya and eleswhere where the normal field crops are mixed

and where type variations are considerable. Resort to hybridization has been accepted in Java and this method is now mainly employed by selectionists in connexion with the padi crop. Emasculation of flowers by means of suction has been evolved and is a useful and rapid method for use in connexion with padi-breeding work. Introductions of varieties have been made for use in this breeding programme and some of the varieties secured from India have been useful. Promising hybrid varieties are planted out into small plots, selections from these are multiplied in small strips, transferred to randomized blocks in the third year and sent during the fourth year to test stations in the districts for trials in further randomized blocks. At the end of the fourth or fifth year decisions are taken as to the types which are worthy of multiplication.

In manuring padi, applications of nitrogen and phosphates have given the best results, but only phosphates can be used with economic advantage.

The most important work on perennial crops relates to derris and kapok. Selection work with derris is being continued in collaboration with the Plant Diseases Institute, and types of high insecticidal value are being multiplied and distributed. Where derris is grown on estates in the Netherland Indies it is usual to dig up the crop for the harvest of roots but when it is grown as a peasant crop it is becoming a common practice for the growers to scoop away the earth from the roots, take out a proportion of these and then cover up the holes thus made. The whole of the roots are thereby never harvested at any one time and the land is not bared of its growing crop. The yields by this method are stated to be not so high as those obtained from a periodic complete harvesting of the crop, but the system of the peasant has certain advantages in that it affords an income more evenly distributed throughout the year and some protection from soil erosion.

Several useful kapok selections have been evolved and one dwarf-growing form is particularly promising and is now much in demand. The procedure adopted in regard to kapok is similar to that which has been adopted for other perennial crops such as rubber, tea, coffee, etc., viz., the isolation of promising selections, their multiplication by budding into clonal groups and the continuance of the use in practice of budding until clonal seed of proved value has been obtained.

The work of *Crop Experimental Stations* it is unnecessary to detail at any length. The research workers connected with rubber in Malaya and Ceylon maintain close collaboration with workers on this crop in Java and Sumatra. Reference has already been made to some of the work which is being done for rubber in both Java and Sumatra in the section of this Report dealing with Malaya.

Tea.

Workers with tea in India and Ceylon maintain close contact with the work being done in Java.

I was, however, greatly impressed by the advances which are being made in Java by the production of improved plant material by Mr. Willanseek of the General Experiment Station, Buitenzorg, and Mr. van Roggen at Pasir Junghuhn. Methods of vegetative propagation have been evolved and very considerable success has been attained. Budgrafting, under Java conditions, has been found to be satisfactory and successes up to 90 per cent. in nursery work at an elevation of 3,000 feet can be obtained by picked and experienced workers. A lower percentage of successes is obtained at higher elevations or in the field but it is well over 50 per cent. and is therefore regarded as being a practical proposition. The inspection was made of numerous selected clones being tested in randomized blocks on Pondok Gedeh Estate and an area of old tea was also seen there which had been cut down and budded to a vigorous-growing selected type. Selection has been made primarily for yield and only those tea bushes which have shown yields equal to at least three times of the general average of the field in which they are growing have been used for trial. The stocks used are ordinary seedling stocks but these are very rigorously selected for vigour. The seeds are tested for their specific gravity and only the heavier seeds are planted. These are sown in nursery beds at distances not greater than one inch apart in rows which are 9 inches apart and 18 inches between every two sets of rows. All the seedlings showing poor growth are weeded out and this process is repeated until the stand is left at 9 inches apart in the row. Budgrafting is then done by the improved *forket* method, the portion of bark containing the bud being cut rectangular in shape. The buddings are wrapped with raffia and examined at 21 days after budding. Those that are then green imply that the budding has been successful, whilst those which are brown mean dead buds and in such cases rebudding has to be undertaken.

One of the tea clones which has been established over a small area at Pasir Junghuhn is extremely promising and very uniform. It has given an estimated yield of 2,800 lb. of made tea per acre and miniature rolling and firing machinery has recently been specially made in order to test clonal teas before they are recommended for general planting.

The Pondok Gedah Estate is keenly interested in the development of clonal teas and its manager, Mr. Ferwarda, co-operates to the fullest extent possible with the research staff at Buitenzorg.

Coffee.

Scientific work for coffee is mainly centred at the Experiment Station for East and Middle Java at Malang. The staff of this station consists of a Director, a Phytopathologist, an Entomologist, a Technological Chemist, two Botanists, two Agriculturists and the Manager of the Selection Estate at Soember Asin.

There is a small selection garden attached to the Station at Malang and amongst the coffees assembled there were included arabica, robusta, canephora, Laurentiana, congensis, Nandi coffee from Kenya and Nganda coffee from Uganda. Selection from robusta strains is the most important work that has been done, but various interspecific hybrids have also been made and tested. The testing of selections is carried out at Soember Asin Estate and this estate was visited in company with Dr. Halle Ris Lambers.

Clean weeding of coffee has been completely abandoned at Soember Asin and selective weeding is now generally practised. Mulching around the coffee bushes is greatly favoured, especially in areas where the dry season is lengthy. Mulching is also recognised as being desirable, but at the present prices for coffee it is not a practicable proposition. Parts of the Soember Asin Estate had been so reduced in soil fertility by clean weeding that abandonment of the areas was under consideration. It was decided, however, to try the use of soft weeds. Seeds of these were collected and sown throughout the estate. At first there was some difficulty in establishing any of them but ultimately species of *Ageratum* and *Salvia occidentalis* were established and the estate now has a good cover of these together with a few more soft weeds. This ground cover is lopped three to four times a year, the loppings being collected and placed as mulch around the coffee trees. Bench terraces were also made to check erosion. The transformation in the condition of the estate since these methods were adopted has been remarkable and at the present time all the coffee is vigorous and yielding heavy crops. Robusta coffee, under the conditions of Soember Asin requires shade and for this purpose *Leucaena glauca* planted 9 × 9 feet, pruned up so that the canopy is 15 feet from the ground, is used. The coffee is planted 9 × 9 feet and is lopped at 6 or 7 feet. It is not pruned as Robusta is self-pruning—the crop being formed on the young wood and when primaries have carried a crop secondaries appear. Soember Asin is 1500-1700 feet in elevation and the rainfall about 90 inches.

The selection work consisted of the isolation of mother trees and the testing of certain crosses. Robusta mother trees were crossed amongst themselves so that legitimate seedlings were

obtained. These were again tested and some of this progeny was isolated, again selected and then crossed amongst themselves. Some legitimate clonal seed is now being produced, on the same lines as has been adopted for rubber, for sale to estates. Arabica x Laurentiana crosses are the most interesting, whilst the Conuga strains (Congensis x Nganda coffee from Uganda) were also most promising.

The selection and breeding of coffees began in 1922 and in consequence the experience has been much longer than that of the Coffee Experiment Station in Mysore or in any of the Departments of Agriculture in East Africa. The number of selected strains now under test is considerable and valuable data has been obtained by the workers at this Station. In addition to selection work, the pests and diseases of coffee have received careful attention, whilst the technological chemist is concentrating on the problem of fermentation. Cytological work has also been started and a histological study of the formation of the embryo in the fruit has been commenced.

To all interested in coffee, a visit to this Station and its Experiment Estate at Soember Asin is well worth while.

Tobacco.

Time did not permit of a special visit to the Deli Tobacco Experiment Station in Sumatra but some time was spent at the Vorstenland Tobacco Station at Klaten in Java.

In the area where this station is situated, tobacco is alternated with padi on irrigated lands—three padi crops are taken by peasants and then one tobacco crop by estate interests which lease the lands from the peasants. The Experiment Station was started because of severe attacks of black shank disease caused by *Phytophthora nicotiane*.—Its work now is principally concerned with the selection of leaf types suited for export to Europe and America. The results which had so far been obtained were given to me by Dr. Middelburg, the Director, and may be summarized as follows:—

(*a*) *Breeding and selection*.—Many pure strains were isolated from the original local varieties, of which there were three. Crossing between these varieties was then undertaken, with repeated back crossing to the Kanari type. Mutations induced by X-rays were also obtained and one of these mutants—called *Chlorina* by reason of its light coloured leaves—proved to be of considerable commercial interest. Introductions of tobacco from Timor showed that these latter types, although of poor quality, were resistant to the *Phytophthora* disease, and some of the crosses between Timor types and the extractions from or hybrids of the local Kanari type have proved to be resistant. By

this means resistant varieties, retaining the quality of the Vorstenland tobacco with improved bright leaf and better fire-holding capacity have been evolved. These new types are in general cultivation and the raising of F_1. generation seed for sale to growers is now being practised. The Timor varieties and their derivatives have also been found to be resistant to odium mildew.

Attempts are also being made to overcome the losses which are occasioned by tobacco mosiac, by means of selection in the progeny of crosses between the mosaic-resistant *Ambalama* variety from Porto Rico and the local Kanari-Timor strains.

(*b*) *Soils and Fertilizers.*—Soil-mapping of tobacco-growing lands has also been carried out in great detail, as information of a detailed nature is required where the intensive culture of tobacco is undertaken. The class of soil upon which tobacco is grown largely influences type, body and texture of the leaf, as well as its burning qualities. The fire-holding capacity of tobacco has, in fact, been found to be correlated with the potash in the leaf in relation to the chlorine and the calcium and magnesium. Fertilizers for tobacco require to be varied according to the type of land on which the crop is grown. Nitrate of potash is preferred as a fertilizer for tobacco than the sulphate, although the latter may be used with safety if the amount in the ash of the leaf does not exceed $6\frac{1}{2}$ per cent. Sulphate of ammonia is, however, used, but as all acidic fertilizers should be employed with caution by reason of their affecting the burning qualities of the leaf, trials are now being made with nitrate of soda. The results so far seem to indicate that nitrate of soda gives better leaf quality than when sulphate of ammonia is employed. Tobaccos grown with nitrate of soda for instance burn with a whiter ash than those fertilized with sulphate of ammonia. It is, however, much more difficult to influence burning quality than to improve the general growth and development of the plant because not only must the absorption of potash by the plant be increased, but also the ratio between the potash and the calcium and magnesium combined be altered.

Virus diseases have been carefully studied and it has been found possible to reduce the " Kroepoek " disease—transmitted by the white fly (*Bemisia* sp.) by the destruction of its alternate wild hosts *Ageratum conyzoides, Synedrella nodiflora* and *Vernonia cineria*.... A mosaic is also transmitted by workers who use infected tobacco for smoking and chewing, and now the hands of workers have to be disinfected in a 4 per cent. solution of formaldehyde before they are permitted to work in the tobacco fields. Thrips, it was reported, could be controlled by spraying with derris preparations.

Other work in which the Station is taking an interest is the selection of Roselle—*Hibiscus altissima*—and the crossing of Roselle with Indian hemp. Roselle is being grown as a fibre crop to an increasing extent on lands which were formerly used for sugar cane or tobacco and one of the sugar factories in the Djokjakarta district has been converted into a fibre factory for the production of sugar-bags from Roselle. Some very fine fields of this crop were to be seen in this area.

Sugar.

The work of the Passoeroean Experiment Station is well known. It was responsible for the advance in plant breeding which led up to the production of the P.O.J. 2878 from crossings between noble canes and the wild *Saccharum spontaneum*. The production of this cane was such a step forward that although it was only planted on lands leased by estates in 1926, two years later it had been planted on 95 per cent. of the area. At present the area occupied by P.O.J. 2878 is about 80 per cent. of the total under sugar-cane, the balance being made up of newer varieties, which on certain soils and under certain conditions give better returns. Of these P.O.J. 2883 and P.O.J. 2965 are worthy of mention.

With the collapse of the sugar industry in Java during the depression, expenditure at the Experiment Station had to be reduced to one-third of the expenditure in 1929 and the personnel to one-half. The present expenditure of the Station is in the order of £56,000. Cane-breeding work is being continued without abatement and about 60,000 seedlings are raised annually. Cytological work is also being continued, but physiological work has been stopped for the time being. The technological section of the Station continues and includes in addition to technological and chemical control work, a large amount of testing of the instruments and thermometers used in the sugar-factories.

The most recent development of the Station has been an intensive soil mapping of the soils on which sugar-cane is planted. It has been ascertained that soil differences occur at short distances because of the varying ages of the volcanic deposits and each type, it has been found, requires special fertilizer treatment. On the heavier types of soil, for example, applications of up to seven and a half cwt. of sulphate of ammonia can be profitably made, whilst on light soils applications in excess of three and a half cwt. have been found not to be economic. An account of this detailed soil survey work was given by Dr Buik at the International Soil Congress held at Oxford in 1935.

The Java Sugar Industry Experiment Station celebrated its half-century of work in 1937, and its record of achievement in that period is one of which the distinguished scientists who have been associated with its work can well be proud.

Cinchona.

In view of the interest which the Colonial Advisory Council of Agriculture and Animal Health has taken in the cultivation of cinchona and of the experimental tests now being carried on in Tanganyika, Malaya and Kenya, it was decided to make a special visit to the Government Cinchona Plantation at Tjinjeroean. This plantation is run as a commercial undertaking but it is the centre at which research and experimental work with cinchona is carried out in the Netherland Indies and from which supplies of high quality planting material are made available to the cinchona industry. It is associated, in management, with the working of the Government Tea Estate (580 hectares in extent) at Pasir Junghuhn where some interesting blocks of tea selections are to be seen and have already been referred to.

The acreage under cinchona at Tjinjeroean is 900 hectares (2,223 acres).

The cinchona industry in the Netherland Indies is an important one and from it, with the exception of a certain amount of production in India for its own requirements, nearly the whole of the world's supplies of quinine are now obtained. There are about 120 estates in the Netherland Indies which are growing cinchona and the total acreage under this cultivation is approximately 47,000 acres—of which 40,000 are located in Java and 7,000 in Sumatra and other islands. These acreages are only approximate as there has been an expansion in planting in recent years and the Government has appointed a Commission to investigate the whole position of the cinchona industry and to ascertain the amount of new planting which is taking place as the Netherland Indies authorities feel that, in spite of restriction of output, more new planting is being done than is generally recognized and the industry's productive capacity is greater than has been assumed. It is also felt in Java that there is a real danger to the plantation industry from the synthetic drugs which are being produced to replace cinchona derivatives in the treatment of malaria.

The cinchona industry of the Netherland Indies may be dated from the finding of *Cinchona Ledgeriana* and the purchase of one gram of seed from Ledger by the Netherlands Government. Ledger found difficulty in finding purchasers for the seed, which he had collected from the Andes in Southern Peru in 1854, but the Netherlands Government eventually purchased one-third of his stock of seed and planted out the seedlings raised therefrom at Tjinjeroean. Survivors of this original planting are still to be seen on the estate and it is clear that the seed was heterozygous as in the population raised from it many variations of habit of growth, leaf and bark characteristics are to be noticed.

Cinchona succirubra was originally grown in Java and various other species were tried. The introduction of *Ledgeriana* completely changed the position and to-day practically the whole of the acreage is planted with this species. There are small areas of *succirubra* but the total extent under cultivation in this species is not large. The variability in the population from the Ledger seed was recognised from the outset by the workers in Java, who proceeded with selection work with the object of determining which were the best types. These were subsequently used as mother trees for multiplication and subsequent propagation. There has been careful and elaborate selection of plant material at Tjinjeroean for the past forty years, and the selection is still being actively continued. The policy adopted is similar to that which has been employed also in the case of tea, rubber, coffee and other permanent crops, viz., (1) the isolation of high quality plant material by individual tests of growth and yields (and in the case of cinchona analytical analyses of the quinine content of barks), (2) the propagation of the isolated material by vegetative propagation, (3) the establishment of isolated seed gardens, and (4) the production of clonal seed by controlled hybridization.

The technique of the industry in its commercial aspects has changed with the advances made at the Government Estate. It was found, for example, that *C. Ledgeriana,* in the Netherland Indies, only thrived on good virgin land, and that attempts to replant areas from which crops of cinchona had been harvested were not successful. Regrowths in the form of coppices also were not satisfactory. It was therefore decided to try hybrids. A number of promising hybrids between *Ledgeriana* and other species of cinchona were raised and whilst they gave better results than *Ledgeriana* on replanted areas, they were not wholly satisfactory. In consequence, it was decided to make trials with grafting and it was found that *Ledgeriana* grafted on to *succirubra* stocks were generally good. Graft wood is normally obtained from gardens specially planted out with selected plants but grafting is also now being done with material from seedlings raised from isolated seed-gardens. These seed-gardens of selected *Ledgeriana* clones have been established with the object of raising legitimate seed from vigorous clones. Such seed is being used for the production of graft wood and also for the production of selected seedlings for planting out in plantations. This seed is in considerable demand and its use is being encouraged. Sales are limited, however, strictly to growers in the Netherland Indies and the price is ten guilders per gram. The best clonal seed is from a type known as Tj. 1. This is a microstyled form and in order to secure fertile seed a microstyled form has to be interplanted with it in the seed-gardens.

C. Ledgeriana is a plant which does not adapt itself readily to a large degree of varying conditions and if the conditions of soil and climate are unfavourable growth is unsatisfactory. The selection work at the Government plantation has widened the range of robust plant material available to growers in the Netherland Indies but even now when the *Ledgeriana* is grafted on to *succirubra* stocks it is still maintained that a loose and friable soil is essential to success in any plantation.

The elevation of the Government plantation is 5,200 feet and the rainfall is about 100 inches per annum. No falls in excess of 3 inches have been recorded and some rain falls in every month—even though the total rainfall in the three dry months of June, July and August is sometimes small. In Java, cinchona thrives best at elevations between 3,500 and 5,500 feet. There is but a small area below 3,500 feet but in Sumatra some plantings have been done as low as 1,000 feet. At this low elevation the bark is thin and there is a much greater amount of disease. The higher the elevation the slower is the growth but the greater is the thickness of the bark and within limitations the higher the quinine content. The problem for the cinchona grower is to find those conditions which promote the greatest degree of bark growth of reasonable quinine content in the shortest period of time. The one essential to success under the conditions prevailing in Java is a loose soil of good depth and fair fertility. The Cinchonas, including even *succirubra* are sluggish root producers and the cultivation of cinchona is not advised on any land in which it was not possible readily to push a walking-stick to a depth of at least $2\frac{1}{2}$ feet. When replanting is done, it is customary to dig over the land with hoes to a depth of 3 feet before the new plants are put out. If any hard pan exists or if the soil is shallow or of poor tilth, the rooting systems of the plants are poorly developed and inferior and unsatisfactory growth results.

Plantation system.—Planting is done at 4 feet apart on the Government plantation but on some estates a planting distance of 3×3 feet has been adopted. This is not advised by the authorities as growth at 3×3 feet is not as satisfactory as when a planting distance of 4×4 feet is adopted. Three years after planting, the first thinning begins—all plants which have made inferior growth are taken out and their bark used. This thinning is continued annually for a few years and then at longer intervals. Under ideal conditions of soil and climate, bark growth continues to be active up to ten years and then slows down. Under these circumstances, a ten-year rotation is practised but the Government plantation at Tjinjeroean works on a twenty-year rotation as bark increase continues for that period. The poorer growing trees are cut out annually until the plantation is twenty years of age and then the remaining trees are clear

felled. An average yield of 7 tons of bark per acre is obtained from a cut-out area, but, of course, there are in addition the yields of bark which have been obtained from the earlier thinnings. These may produce in all an additional 3-4 tons of bark per acre. Estates which work on a ten-year rotation—and they can only do this when conditions are extremely favourable—obtain yields of bark somewhat lower than those given above, but I gathered that an average of 8-9 tons of bark per " coup " was considered satisfactory, whilst well-managed estates aimed at yields of 10 tons.

Terracing is done when it is considered to be necessary, i.e., on steep slopes, or near to the natural drainage channels. Silt pitting to catch soil wash is general and selective weeding is generally practiced. Trials with manures have been made in some places but in Java manurial applications are not considered to be necessary as soil fertility is naturally high, and provided that measures are taken to protect it from erosion and to return to it some organic matter through a " soft-weed " growth, the addition of fertilizers is unnecessary. Tilth and friability is apparently of much more importance in cinchona cultivation in the Netherland Indies than any other soil factor.

The cinchona trees when they are cut out are divided into log lengths and the bark is beaten off from them with wooden mallets. This bark is then sun dried on moveable trays, similar to those used in the " boucan " type of cacao driers used in certain parts of the West Indies. The final drying is done by placing the bark for one hour on trays in a hot-air oven. (The Chula type of drier is used in some places.) The dried bark is then disintegrated in an ordinary disintegrating mill and is packed into jute bags for export. These bags (in order to save on freight) are beaten by wooden mallets into rectangular shapes of uniform size. Special moulds are used for the purpose of reducing the bags to uniform size and when the operation is completed they resemble in shape the bags of cement with which one is familiar, but, of course, of larger dimensions. A saving of one guilder per bag freight has been made possible by the production of bags of bark which are rectangular in shape and of uniform size. With the cheap labour in Java this reduction on freight charges has been found to have been well worth while as the shaping of the bags does not cost more than 25 guilder cents per bag. The use of presses was tried, but it was found that they were not successful as the bags—under pressure—burst.

Succirubra bark is also prepared to a small extent for export from Java. This is prepared in the form of quills of two specified lengths. The bark is taken off from the cut lengths of the trees by means of specially designed knives, each section of the bark being one-quarter of the circumference of the tree and of the

length decided upon. The bark when still fresh is rolled into quills on pieces of bambo and then dried. The moss and lichens on the bark are not removed and any pieces of bark from which the moss is rubbed or broken off are separated from the bulk samples and shipped separately. The trade demands that *succirubra* bark shall be moss and lichen covered. A small export of bark in special diamond-shaped sections is also made. Roots of *succirubra* were also formerly used and the bark from them exported, but since the restriction scheme has been in force this procedure has been stopped. *Succirubra* roots from the stocks of grafted plantations or from seedling plantations are now used solely for fuel and the bark from them—although it is more rich in alkaloids than is the stem bark from the same species—is no longer prepared.

The Restricted Scheme.—The export of cinchona from the Netherland Indies is now reduced under a restriction scheme to 45 per cent. of the productive capacity of the plantations. The marketing difficulties arose because there was no control of production and no organization of producers, Production, in consequence, exceeded the demand and manufacturers, who had a working system of combination, found larger supplies of raw material available than they could absorb. In consequence, prices fell to unremunerative levels, and the manufacturers, with stocks in hand, could for a time depend upon securing supplies adequate to their needs from weak sellers. Bark was disposed of by some sellers at prices which were quite unprofitable and then the producers decided that the industry would be ruined unless they combined together in order to meet the combination of the manufacturers. They decided at first to refuse to sell any bark at all as cinchona bark improves, within certain limits, by remaining on the trees. In the majority of cases, cinchona is grown on estates in combination with other crops and the number of weak sellers were few. For a short time a deadlock seemed to be inevitable, but then the Kina Bureau was formed. This has its headquarters in Amsterdam and it operates as regulating machinery between consumers and producers. The Kina Bureau, with assistance from the manufacturers, estimates the likely world demand for quinine and cinchona derivatives and exports of bark from the Netherland Indies are regulated accordingly. Prices are maintained which are profitable to the growers and that this has been the case is clear from the increase of interest and the extension of planting which has taken place in recent years. The exact position of the industry is not definitely known at the present time and, as has been stated before, an enquiry is being undertaken by the Government.

Quinine factory.—There is one quinine factory at Bandoeng in Java but I gathered that at the present time this only

turns out the quinine required in the Netherland Indies. The greater consumption of quinine is in the Outer Provinces and their supplies are all provided from the Bandoeng factory. *Ledgeriana* bark is exported in disintegrated form, whilst *succirubra* bark is shipped in quills for pharmaceutical purposes and for the medication of wines. For this latter purpose, there is a fairly large demand, under normal conditions, from Spain and Portugal and to a lesser extent from Italy. Each market demands special types of quills or special sizes and shapes of bark pieces, but all bark is sold through Amsterdam.

Nursery and Grafting Technique.—The technique of the work at the Government Plantation was explained to me by Mr. M. van Roggen:—

The seed is collected from the clonal gardens of *C. Ledgeriana* which have been established and it is of importance that in these gardens both microstyled and macrostyled forms be planted. Selection of mother trees has, as has already been stated, been going on continuously for the past 40 years. One of the best clones is Tj.1, and this has a somewhat roundish leaf which reminds one more of the hybrid cinchonas than the lanceolate-leaf types which are generally regarded as being typical of the true *Ledgeriana*. In fact, it was quite remarkable to notice at this station, the extent to which selection is moving away from the narrow-leafed types which redden readily in dry weather towards a series of more robust forms with rounder and broader leaves. The narrow-leafed types are almost invariably poor growers and do not stand up to severe climatic conditions. Selection is based firstly upon the vigour of growth and secondly upon cinchona content. More importance is attached to vigour as *C. Ledgeriana* is a plant which does not readily adapt itself to unfavourable conditions of soil and climate and thrives well only under clearly-defined limits.

Measurements are made regularly of tree girths and of bark thickness at one metre for the growth. Tests are also made of quinine content. These are done by the removal of round test plugs of bark about one inch in diameter at one metre from the ground at yearly intervals after the plants obtain a girth measurement of about nine inches.

All clonal seeds and also the seed of *succirubra* used for nurseries for stock purposes is subject to rigorous selection. Germination and subsequent growth depends upon the size of the germ and the quantity of food supply in the seed. Each seed is examined upon a glass table over an electric light. The size of the germ and the food supply can readily be determined by this means and any seeds which show signs of a discoloured rootlet in the embryo are discarded. This selection of individual seeds is done by specially trained women and the good seed is separated from the bad by means of light feathers. Germination tests are made of all seed selected and

a germination of 90 per cent. within 19 days is required. The viability of the seed naturally decreases with age, but seed can be kept under suitable conditions of storage for a considerable time and at the time of my visit to the Government Plantation there was one nursery bed of seedlings which had been raised from seed which was four years old.

Nursery technique.—One of the difficulties experienced in cinchona cultivation is met with in the nursery stage. At the Government Plantation, seed of *succirubra* (and there is no selection of mother trees of *succirubra*) is sown thinly on the surface of specially prepared seed beds. The soil of these beds must be fine and must contain a fair proportion of sand and finely divided organic matter. These are shaded with glass and split bamboo, or only with split bamboo, frames. After the seed has been sown it is sprayed lightly with water by means of a spraying machine. This fixes the seed to the soil. Covering the seed with soil has been found not to be desirable. Similar waterings by means of mist sprayings are given whenever necessary. In dry weather these sprayings are required daily, but in dull weather less frequent waterings are necessary. The provision of the requisite amount of shade in the nursery beds is essential. The seed germinates in about two months from the date of sowing and at four to five months the more vigorous seedlings are selected and transplanted into *shaded* nursery beds at distances of about six inches apart. This transplanting stage is an important one and the right degree of shading is required if success is to be achieved.

Grafting.—At about one year after transplanting the seedling *succirubra* plants are ready for grafting. The system practised successfully in Java is a form of side graft, i.e., the insertion of a scion whose end has been sharpened in the shape of a wedge, into the side of the stock. The scion is taken from shoots which are green and about half a pencil in thickness. These shoots are cut into lengths each containing two " joints ", the upper part of the scion being cut off about one inch above the upper " joint ". Through the lower " joint " cuts are made to produce a sharpened wedge-shaped lower end of the scion for insertion into a downward slanting cut made into the side bark of the stock. The portion of the bark of the stock which has been cut to permit the insertion of the wedge-shaped end of the scion is then tied back with wrappings of raffia and the whole completely enveloped in a thick casing or warmed wax in order to provide a water-proof covering to prevent the ingress of bacteria. When the buds on the scion begin to shoot, the stock is cut back one foot above the insertion and when one bud has grown into a shoot about one foot long the stock is further cut back to the junction of the stock and scion. Grafted plants are ready to be put out into the field when they are two and a half years old from seed.

In Colonial Dependencies there have been difficulties experienced in nurseries of cinchona and in securing satisfactory results with grafting. The above somewhat detailed descriptions of the Java methods have therefore been given in the hope that they may be of some assistance to Colonial workers.

Cinchona in Ceylon and Malaya.

Ceylon, between the disastrous collapse of the coffee industry and its replacement by the tea industry, had a thriving cinchona industry. This was based upon *C. succirubra*, but it became quite unprofitable when the Dutch began to develop plantations of *C. Ledgeriana*. The cinchona plantations in Ceylon were cut out and planted with tea and to-day only small numbers of *C. succirubra* plants are to be found in the colony and these are usually to be seen in the ravines and along the banks of small streams in some of the tea-growing districts. From them small quantities of bark are harvested each year and the exports of such bark range around 500 cwt. per annum. Several attempts have been made to establish *C. Ledgeriana* in Ceylon, but they have all been unsuccessful. The most recently planted areas at Hakgala were inspected by me, in the company of the Governor, during my recent visit to Ceylon and it was clear that they were making very poor growth and could only be regarded as being quite unsatisfactory. The soil and climatic conditions at Hakgala are unsuited to *C. Ledgeriana*, and the only area in which I would suggest a further trial of this species in Ceylon would be in the Welimada district—but it is probable that this area may be too low in elevation.

Judging from observations made in Java, I concluded that there was little possibility of successfully developing areas of *C. Ledgeriana* in Ceylon. The Government of that colony is, however, desirous of doing all it can to test the possibilities. Arrangements had accordingly been made to send the Economic Botanist to India to study cinchona cultivation there and I was able to see Dr. Haigh before he left for India and to supply him with copies of the notes made in Java.

In Malaya, the position is somewhat more promising. Small trials of *C. Ledgeriana* in the Cameron Highlands have been reasonably successful and arrangements have been made for further tests in other parts of the highland area. The soils in the Cameron Highlands are friable and the rainfall is adequate for cinchona and is evenly distributed. The main difficulty is the relative steepness of the slopes of the hills and if any development of cinchona cultivation is to be encouraged, great care will have to be exercised in the selection of land with as gentle a slope as possible. Otherwise, erosion is bound to occur and it will be difficult to arrange for successful replanting once the original plantings are harvested.

There are many conditions there which are encouraging and a thorough trial of the possibilities would be worthy of serious consideration. Beyond an extension, however, of the test areas, unless selected seed from high-yielding mother trees could be obtained, it would be inadvisable to proceed at the present time. The nursery plants for the five test plots now being established in Malaya were seen during my visit to the Cameron Highlands Experiment Station and I was not greatly impressed by them. They were mainly of the narrow-leaved *Ledgeriana* type and many of them, by the red tinge in their leaves, were not at the time of my visit making satisfactory growth. It was clear that much had yet to be learned about cinchona growing generally and about the response of *Ledgeriana* either on its own roots or grafted on to *succirubra* stock before one could advise, with any degree of confidence, any large extension of cinchona in the Cameron Highlands area.

Conclusions.

The conclusions reached after a careful examination of the position in the Netherland Indies were, as far as the Colonial Empire is concerned as follows:—

(1) That much more careful experimental and investigational work is necessary before it can be concluded that parts of the Colonial Emipre are suitable for the cultivation of *Cinchona Ledgeriana*. The conditions in the Cameron Highlands of Malaya are—owing to the greater friability of the soils—probably more favourable than the Usambara hill range in Tanganyika, even though coppicing has been found to be possible there. Further trials, where rainfall conditions are favourable, in parts of Nyasaland, Kenya and Uganda would be worthy of contemplation in addition to the trials already started in Malaya, Tanganyika and Kenya, as the result of the earlier recommendations of the Cinchona Sub-Committee of the Colonial Advisory Council of Agriculture and Animal Health.

(2) The *C. Ledgeriana* planting material of the Netherland Indies is far superior to any which is available in the Colonial Empire. It is unlikely that any of this will be available for use outside the Netherland Indies and if seed from selected mother trees is not availible from India selection work should be undertaken at Amani on behalf of the Colonial Empire.

(3) Thorough trials should be made to test the efficacy of Totaquina, from *succirubra* bark,with a view to considering whether its use could not be adopted in place of quinine, especially if it is found that progress with the cultivation of *C. Ledgeriana* in the British Empire is not

practicable by reason of conditions of soil and climate being unsuitable. *C. succirubra* is much more adaptable to varying conditions of soil and climate. It is generally more robust and can be grown at elevations lower than those necessary for *C. Ledgeriania* and Totaquina from *C. succirubra* bark can be prepared at less cost than the present cost of quinine.

Sisal.

Fibre production in the Netherland Indies is in the hands of large companies. The Handelvereeniging, Amsterdam, produces from its estates nearly two-thirds of the total output and the Anglo-Dutch Plantations Limited is another important producer.

In the cultivation and preparation of sisal in the Netherland Indies there are variations from the practices which are commonly employed in the East African dependencies so that some account of the industry may be of interest. I am indebted to the Anglo-Dutch Company for permitting me to visit their sisal cultivations and factory at Soekamandi and of discussing matters with their sisal manager, Mr. Fletcher, who has visited East Africa and their technical adviser Mr. J. E. A. den Doop. Exports of hard fibres from the Netherland Indies now approximate to 95,000 tons per annum of which about 15 per cent. is *cantala* fibre and the balance sisal. The ratio of *cantala* is decreasing as it is not so easy to cultivate or to handle as sisal.

All planting is done from bulbils. These are planted out into nurseries and may be kept there for up to two years before they are transferred to the fields to be planted up. At the time of planting the young plants are about 1½ feet in height.

The sisal lands are divided into beds by drains and are usually planted with three double rows of sisal per bed. The plants in the rows are 3 feet apart, but on other properties a planting distance of either 2 or 3 feet apart in the rows is adopted. The spaces between these double rows of plants may be either 8 or 9 feet. All the drain edges are covered with *Centrosema pubescens* to prevent the wash of soil into the drains. Clean weeding is generally practised, but on other estates where wide spacing between the double rows is practised the growing of strips of green cover crops has been adopted. *Centrosema pubescens* is favoured for this purpose but trails are also being made with *Indigofera endacaphylla*. By some, however, it is maintained that this use of green cover crops retards the growth of the sisal, particularly during the first half of the planting cycle of eight years. In some cases, therefore, and on some soils, the practice of growing green cover crop strips between the

double rows of sisal is adopted only on sloping lands in order to check erosion. Clean weeding between the sisal plants in the rows is carried out at regular intervals and all suckers are removed as they appear.

Cutting is restricted to leaves which are accepted as being mature, i.e. form an angle of 45° with the stem. This begins at about 18 months after the fields have been planted and continues at regular intervals of six months for up to six years. An average of 12 to 13 cuttings is general before the area has to be replanted. All poles are cut off as they begin to appear. They are never allowed to develop except when bulbils for replanting are required. When the degree of poling reaches 50-60 per cent. of the whole plantation uprooting begins and the land is then placed under a green cover crop for a period before replanting is undertaken.

Decortication and treatment of the fibre in the factory is centralized; many factories containing upwards of 12 decorticating machines. The Corona No. 2 is generally favoured for decortication although trials have been made with other types of decorticators. A very much greater quantity of water is used in the Java factories than is the case in factories in East Africa. It has been stated that the quantity of water used is approximately five times the average used in East Africa.

Leaves as they are cut are graded in the fields according to length, and in this way grading of fibre subsequent to decortication is avoided. Decortication of leaves of a given length is completed before those of another length are dealt with, or the leaves of different grade lengths are fed to different decorticators. The Java system is to feed the decorticators more slowly than is customary in East Africa and it is rare to see any one leaf superimposed on another. This feeding of the leaves into the decorticators is given close and careful attention because it is realized that it is only by so doing that an even decortication can be achieved. Factories are worked for the 24 hours in three shifts and continuous attention is given to the machinery. Large workshops are maintained for the supply of spares which are required in the factories and for all necessary repairs and adjustments.

Immediately the fibre comes from the decorticators it is transferred to centrifugals where it is thoroughly washed. This washing removes all the substances which tend to discolour the fibre and the fibre comes from the centrifugals white in colour. This is then dried in hot air driers of the Chula pattern, collected and lightly beaten on fixed wooden rails to remove any adhering particles of pulp. Afterwards, it is baled. No brushing of the fibre is done, nor is it necessary.

Tow is collected from the flumes, washed thoroughly, tossed to loosen the adherence of the strands, dried, tossed again and then packed.

Considerable thought has been given to the utilization of the factory waste. The waste fibre and its adhering tissues are mainly used for fuel for the hot air driers whilst the waste water and the particles of leaf tissues floating freely in this water are used for manurial and irrigation purposes. This " waste water " is run on the level fields at intervals of three weeks and the results obtained have been most encouraging on the grey soils.

A series of manurial trials have been carried out and before replanting the application of a mixture containing nitrogen, potash and phosphates is given. The most important constituent of this mixture is held to be nitrogen, although certain areas are supposed to be short of potash, as leaf droop and blackening of the sisal leaves is thought to be due to potash deficiency. A few small areas where this leaf droop occurs were seen.

Organized research by the sisal industry has not been undertaken, but the large production groups carry out investigations for the estates under their control. This work has so far been mainly concerned with manurial trials and soil treatment and with efforts to improve efficiency in decortication and factory management.

Agricultural Education.

Agricultural education is provided in various schools and through courses of instruction given to elementary school teachers and in the villages themselves. The latter are used by the agricultural extension service for the dissemination of information and for propaganda, whilst the courses at the higher schools aim at providing biological and agricultural knowledge as a foundation for general agricultural progress.

The *Agricultural High School* at Buitenzorg provides a three years' course in agriculture and forestry. The medium of instruction is Dutch and the school is residential. One-third of the time at the school is devoted to practical work and instruction is given not only in cultural operations in the fields but also in building construction, irrigation engineering and surveying. All students also now have to take courses in motor engineering and electric lighting. Those proposing to go on to estates receive instruction in mechanical engineering and those on the forestry side of the school in railway construction.

The students make many of the requirements of the school and are required to dismantle and fit up the lighting of the workshop, make accumulators, and to learn the workings of a motor-car and to fit up its wiring.

The diploma of the school is accepted for entry into the extension service of the Department of Agriculture, the Forest Service and for employment on rubber, tea and coffee estates.

Since the depression an average of 20 pupils have left the school annually and have had no difficulty in securing employment: the numbers have again risen considerably as the demand for trained diploma-holders of the School had during the past two years exceeded supply.

The students in forestry have received their practical training in the field under Forest Officers, but it is contemplated that the forestry course will be in the near future given at a special Forestry School located at a Forest centre.

There is also provided at the School an agricultural course for teachers. They will become teachers of agriculture at the rural schools, as it is held that for teaching in agricultural classes specialized training is necessary and that instruction in agriculture cannot satisfactorily be entrusted to the ordinary teachers.

The *Secondary Agricultural School at Malang* also provides for a three years' course in agriculture or forestry and for an additional fourth year for those who are taking up work on rubber, tea or coffee estates. The medium of instruction, as for the Agricultural High School at Buitenzorg, is in Dutch, but the general standard of instruction is lower than that given at Buitenzorg.

This school at Malang is non-residential, the pupils finding lodgings at approved houses in the town. All pupils at the school do field work on the 70-acre farm from 6-9 a.m. and receive school instruction from 10 a.m. to 1 p.m. The first two years are spent on general biological and agricultural work and in the third year the school course bifurcates into (1) more advanced agricultural courses and (2) forestry. The fourth-year course for those going on to estates is devoted to the thorough grounding in mechanics, building construction, general engineering, motor engineering, irrigation, etc. Adequate provision is made for practical work in connexion with these engineering courses.

At the time of my visit there were 172 students at the school. Every year an average of 40-50 leave the school and the fourth-year course generally averages about 15 students.

The diploma of the Malang school is accepted for entry into junior positions in the Agricultural and Forest Services and those who take the fourth-year estate course secure employment on rubber, tea and coffee estates.

Farm Schools.—A system of Farm Schools, giving two-year courses in the vernacular, with emphasis on the practical aspects of agriculture, was started some years ago for selected boys from the highest standards of the elementary schools. They were started with the object of providing a sound agricultural

training to the sons of smallholders in the hope that this would enable them to assist in bringing village agriculture to a higher level of development. The training was adapted to the local agricultural conditions. The pupils are provided with simple housing accommodation but they have to feed themselves. Much of their food they grow on the farms on which the schools are located and the proceeds of the permanent crops grown on the farms are divided equally between the Government and the pupils.

There are now five of these Farm Schools remaining, four in Java and one in the Outer Provinces. They were reported not to have achieved in Java the objects for which they were established as there is no spare land for the pupils to occupy and little improvement has been noticeable in agricultural methods after the return of these trained pupils to their homes. There is greater promise of success in the Outer Provinces—particularly when colonization is practicable or under contemplation.

It has recently been decided gradually to abandon the Farm School idea in Java and to concentrate upon the introduction of agriculture into the highest classes of selected rural elementary schools and to provide for village courses. For this purpose teachers are given special training in agriculture.

Teachers' courses.—These consist of courses provided at the Pantjasan School near Buitenzorg for theoretical and practical training in agriculture to selected teachers in order to enable them to teach agriculture to the sixth classes of selected rural extension schools. Every year ten to sixteen teachers are given this special training.

Elementary education in the Netherland Indies provides for five years' education and to this has been added since 1930 a sixth year of agricultural instruction at selected schools for selected pupils. This sixth year is devoted to instruction impregnated with the rudiments concerning rural life, in which agriculture takes the foremost place. Practical work in the school garden is part of the training given in this extra agricultural class and it is hoped thereby to promote an appreciation of and love for rural life and the agricultural industry of the countryside. The standard of entrants for the village agricultural courses will thereby gradually rise.

These *village courses* have been started in those regions in Java where the farmers have shown a tendency to economic aspiration. They are held once or twice a week by teachers who have been specially trained by agricultural extension officers. The training courses for teachers for the village courses in agriculture are given at the rate of four hours a week, spread over one or two years, and the teachers are afforded travelling facilities in order to attend them.

Seven courses are given in Java and three in the Outer Provinces.

In 1936 there were 3,035 adults and young people who attended the village courses in agriculture given in Java and 350 those given in the northern part of Celebes.

Societies of old students of village courses.—These societies have been formed by the agricultural extension service in collaboration with the agricultural education service in order that contact may be maintained with those who had attended the village courses. The village headman and prominent farmers are also invited to join in this movement, and the teachers also have an important part to play. It is felt that through these societies it should be possible to guide rural development and ensure that the results of agricultural research are translated into the practice of the cultivators.

Credit Facilities.

These are provided in the Netherland Indies through the People's Bank, Village Banks, Padi Banks and Co-operative Societies.

The People's Bank now has seventy branches and these do not deal in loans, against tangible security, of less than 50 guilders. They are located in urban centres and are mainly used by urban workers.

The Village Banks number 7,000, and cannot deal, without excessive charges for overhead expenses, in loans of less than 25 guilders. The majority of the loans are, however, for sums less than this amount, a common form of loan being 10 guilders repayable with interest in eleven weekly instalments. These banks are used by petty traders and the urban communities.

The Padi Banks, which also number 7,000, provide for credit to the rural population. The loans are uniform in amount and are given at three periods—the first at the time of cultivation, the second at the time of transplanting and the third just before harvest. Stores are provided for the padi after harvest, and from the padi brought into store the refunds of the loans issued are made. Loans may be repaid in padi and interest on loans is similarly repayable in kind.

Co-operative Societies now number 400. These have developed in the area near to Batavia, where education has extended to a greater extent than in other parts of the island. Their development has followed a demand from an educated community, with business sense and a certain degree of national spirit. The general policy adopted is to encourage thrift and to allow, as far as possible, societies to handle funds which they have collected themselves from their members. In some instances borrowing by societies has been permitted, but this is restricted to 20 per cent. of the capital collected from members.

The danger of easy credit is appreciated and it was stated that strict supervision over the operations of the societies was necessary, as otherwise they soon get themselves into financial difficulties and liquidation.

It is held by the authorities of that section of the Department of Economic Affairs which deals with rural credit that co-operative societies make sound progress only when the members have attained a certain degree of education and have had some acquaintance with business.

Some relief co-operatives, with funds advanced by the Government, have been formed in Cheribon, in East Java, where indebtedness is considerable. I was able to visit some of these societies with the officer charged with their supervision. The debts of members have been taken over and in return their crops of padi and mangoes have been hypothecated to the societies. It is expected that their debts will be liquidated in six years and in the meanwhile members are provided with small seasonal loans for living expenses. These current loans are the first to be recovered when the crops are harvested and the balances available are set against the long-term loans given for debt liquidation. Enthusiasm is still shown by the people concerned, but the societies require constant and close supervision. It is held that it is yet too early to say whether this method of dealing with rural indebtedness will be successful.

Co-operative marketing societies have not been attempted as there are over one million petty traders in Java and competition is so keen that no co-operative marketing organization would be able to operate.

The Government-controlled pawnshops also provide a ready means to the rural population of obtaining cash funds when they are in urgent need. The variety of the articles pledged in these pawnshops is considerable, but amongst those articles which figured most prominently in the one which I visited were bicycles, lengths of cloth and jewellery.

Summary.

The outstanding impressions made by this visit to the Netherland Indies were the importance which was attached by all to soil conservation and the maintenance of soil fertility and also the importance which has been and still is attached to crop improvement by the work of plant breeders.

2. Not only have plantation crops been improved but most valuable work has also been done in connexion with food crops and in the evolution of strains of plants resistant to various pests and diseases. In the efforts to improve plantation crops the plant breeders have been assisted by co-operation from estate superintendents—many of whom received a full training in the sciences of agriculture before they proceeded to the East.

3. The British Colonial Empire can learn much from the achievements of the Dutch in the Netherland Indies and it is clear that greater emphasis should be given in the future to the work which can be performed by plant breeders for the development of tropical agriculture. The numbers of plant breeders in Colonial Departments of Agriculture are clearly too small if progress is to be maintained or improved.

4. Accounts have been given of the work of Agricultural Experiment Stations and of the observations made in regard to cinchona and sisal production in the Netherland Indies as it is felt that these may be of value to British Colonial interests. Brief notes are also given in regard to Agricultural Education and Credit Facilities in the Netherland Indies.

5. The proposal to abandon further development of Farm Schools in favour of increased agricultural teaching in the elementary schools was noted, as experience in regard to vocational training in agriculture in Farm Schools in the Netherland Indies is very similar to that which has been experienced elsewhere in the tropics unless there is scope in the country concerned for further land development and colonization or for employment in connexion with such undertakings.

CEYLON.

The stay in Ceylon was only of short duration. It was devoted to visits to the Research Institute which had been created for the three major industries of the island—tea, rubber and coconuts—and to the headquarters and some of the district undertakings of the Department of Agriculture.

The separate Research Institutes for the tea, rubber and coconut industries are now firmly established and are doing most useful work for the industries for which they were created.

Tea Research Institute.

The Tea Research Institute, which was founded in 1925, is maintained entirely by the industry and has well equipped laboratories and factory situated at its tea estate and experiment station at St. Coombs, Talawakele. The work of its officers in the field of soil chemistry, the manurial requirements of tea under Ceylon conditions, plant physiology, plant pathology and the technology of tea manufacture has been of a high standard and is valued by the industry. The elucidation of the causes which give rise to die-back after pruning has a particular interest also for workers in East Africa where the die-back of coffee has also been found to be due to a shortage of carbohydrate reserves. The statistical technique evolved by the soil chemist for field experiments with permanent crops, such as tea, has an interest amongst tropical agriculturists much wider than the tea industry of Ceylon.

A small-holders' advisory service has also been evolved and it was reported that as a result of this service and of the prize holding competitions many small-holders were effecting considerable improvements in their holdings.

The Institute is now beginning to take a more active part in the matter of soil erosion in the tea growing districts. This, I am convinced, is necessary for whilst some areas showed that estate managements were endeavouring to secure satisfactory ground cover and increases of green manures, I passed through estates which showed a much higher proportion of bare land than I had anticipated. The appearance of these estates resembled those of the old clean-weeding days which it had been hoped had passed away for ever as far as Ceylon was concerned. I gathered from enquiries made that on these particular estates all litter and leaf fall had been collected—the ground might in fact have been brushed clean of all debris and leaves—for the preparation of compost. A more unsatisfactory agricultural operation on the hilly lands of Ceylon could not be imagined and it was gratifying to learn that the risks of soil deterioration and accelerated soil erosion were beginning

to be realized and that steps were being taken to discourage the procedure. In those areas where this system of compost making had been started I was astonished at the amount of bare soil which was to be seen and it can only be a matter of a few years before the effects of increased soil deterioration are experienced. The value of composting waste organic materials which would not otherwise find incorporation in the soil is recognized but the introduction of a system of removing plant debris and leaves from areas where it would naturally become incorporated in the soil and where it is useful to check soil waste is to be deplored. The practice was, I gathered, started without experimental investigation and did not have the support of any of the scientific workers at the Institute. Work has now been started at the Institute to investigate the decomposition of plant materials, the effects of ground covers and cultivations on yields and the value of green manures in tea cultivations. The results of these investigations will be watched with interest by all concerned with tropical agriculture.

More, however, requires to be done in the tea growing districts of Ceylon to check erosion and soil deterioration, and it is to be hoped that definite efforts will be made by all concerned to effect an improvement in every way possible.

Rubber Research Scheme.

The Rubber Research Scheme has since I left Ceylon in 1928 transferred from Culloden Estate to a property of its own—Dartonfield. New laboratories and residences for the staff have been erected and additional land has been made available for experimental work. I visited some of the experimental areas and saw the advances which had been made in the selection and testing of improved plant material. Satisfactory measures have been taken to control erosion on hilly lands and trials of cover crops have been a feature of the field work. The new laboratories are well designed and equipped and the officers have carried out work of value to the rubber industry of Ceylon. Technological work connected with the production of manufactured rubber goods in Ceylon has also been carried out, but it is expected that this work will be curtailed as the prospects of developing rubber-manufacturing industries in the island are not encouraging. In this connection, I would like to suggest that attention be given in Ceylon, as it has been in India and the Netherland Indies, to the developement of the use of rubber tyres on the wheels of bullock-carts, still employed largely for transport purposes particularly in the rural areas. Less wear on the roads should follow the adoption of such a practice and an outlet for the use of rubber locally might be created. Whether the use of pneumatic tyres should be advocated or

whether as a first stage solid rubber tyres could be employed would have to be determined locally and it might also be considered whether licensing authorities should not endeavour by reduction of taxes on rubber-tyred carts and possibly by means of advances to cart-owners desirous of making the change, to encourage this line of development. Full particulars of the present position in India could be obtained from the Indian Roads and Transport Development Association Limited, 41, Nicol Road, Ballard Estate, Bombay.

Another matter concerning rubber to which I gave attention when in Ceylon was the extent of the occurrence and damage done by oidium leaf disease. This disease is now common and is worse in some years and less severe in others. Dusting with sulphur is satisfactory as a control measure in certain years, but if weather conditions are very unfavourable control of the disease by dusting becomes difficult if not impossible. It is held that on balance it is economic to dust. The real long-range view in regard to this disease must, in my view, be the evolution of strains of rubber resistant or immune to the disease. Further search should be made amongst the rubber population of Ceylon—and also in collaboration with the workers in Java amongst the rubber population in East Java—for any plants which show resistance. The introduction of other species of Hevea may also be necessary for breeding purposes if any of them show any resistance to the disease. An examination was made with the Director of Agriculture of the rubber trees along the river bank at Peradeniya Botanic Gardens. These represent progeny from introductions into Java from South America subsequent to the earlier seed introductions and, although it may have been accidental, one or two of the plants at the time of inspection seemed to show less effect from oidium attack than did the others. The production of oidium-resistant strains is admittedly a long range piece of scientific work, but it should nevertheless be seriously considered in the interests of the industry not only of Ceylon but of the East generally. Furthermore, it is not clear that the life history of the fungus has been fully and completely ascertained under Ceylon conditions. Here is a piece of research work which could be undertaken by a Ceylonese post-graduate Research Probationer under the supervision of Mr. Murray, the Botanist and Mycologist to the Ceylon Rubber Research Scheme. The method of carry-over from one season to the next seems, particularly, to require further investigation.

These proposals have since my return to England been discussed with members of the London Advisory Committees for Rubber and a communication on the matter is being addressed to the Board of Management of the Ceylon Rubber Research Scheme.

Coconut Research Scheme.

The Coconut Research Scheme has been established at Bandirippuwa and during my visit to the laboratories and experiment station there I was met by the staff and some members of the Board of Management of the Scheme. We discussed the work which had been undertaken and visited together the several field plots and the different laboratories. This Station is new since I left Ceylon in 1928 and it was a great pleasure to me to see the development which this station had made and to ascertain the high esteem with which its work is held by the industry.

Technological work in regard to copra, soap making and the utilization of coir fibre has been undertaken by the Technological Chemist, crop improvement has received the special attention of the Geneticist, and the manuring of coconuts, including the use of green manures, has been studied by the Soil Chemist. There is a good demand for advisory work from coconut growers and the demands for seed nuts or seedlings from selected high-yielding palms exceeds the supply.

There is no doubt that this Research Scheme is serving the interests of the coconut industry and that the importance of its work is becoming recognized amongst an ever-increasing circle of producers of coconut products. Its work is well organized and the results which have so far been secured have been appreciated. It was suggested during my visit that a further critical study of the mechanism of the pollination of the coconut under Ceylon conditions was required because of the differences which appear to exist between the findings of previous workers on this question in Malaya, Ceylon and South India. The Geneticist thought that this scientific investigation could be undertaken and it is not without bearing on the work of selection and plant-breeding which has already been commenced.

Department of Agriculture.

With the establishment of these crop Research Institutes, the Department of Agriculture has been enabled to pay greater attention to the needs of those growing padi and secondary crops and to the agriculture of the peasant smallholders. Its work has been largely educational and it has paid special attention to fruit cultivation and to certain secondary money crops. Work is, for example, in hand in connexion with cacao, cotton, cashew, castor, chilli, citronella, coffee, sesame, eleusine and tobacco. Trials are also being made with soya beans and with a soft-shelled type of adlay (*Coix Lachryma-Jobi*).

Very considerable progress has been made with the development of fruit growing, especially of citrus, in spite of occurrences of citrus canker. Inspections were made of plantings developed

in dolomitic limestone areas and in the low country under irrigation. Grapefruit under irrigation was doing well and some very promising areas of young plantings were seen. Stock and manurial trials with grapefruit, oranges and mandarins were being carried out and further work with mangoes, pineapples and other fruits undertaken.

There is an increasing demand for fruit in the Colony and as difficulty was being experienced with imports from areas infected with Mediterranean fruit-fly it has been decided in the general interest to limit imports under licence issued by the Department of Agriculture to those importers who can secure supplies which are certified under a Government system of inspection as free from fruit-flies.

Considerable advances have also been made with animal husbandry and poultry-keeping, and special attention has been given to fodder grasses.

The Chemist of the Department of Agriculture, in addition to soil studies has also undertaken experimental work in connexion with fruit-canning and analytical work in regard to the nutritional values of different foodstuffs.

The Department also has started recently to demonstrate amongst small-holders the evils of soil erosion and to interest them in the need for the preservation of their soils and for the development of sound methods of agriculture. Some of the small experiment stations which had been laid out with due regard to soil conservation were visited and there is no doubt that they are useful models for demonstration purposes.

In regard to paddy, the main food crop of the island, an insufficient amount of work was, I felt, being done. For a period selection work ceased, but the need for special work by the Department of Agriculture as an accessory to the developmental work by the Irrigation Department and the colonization schemes has again been realized and an officer has been definitely assigned duties as Paddy Specialist. There can be no doubt that efforts to make Ceylon more self-supporting in its rice supplies should not be relaxed.

Discussions were held with the Commissioner for Agricultural Marketing, the Director of Co-operation and the Director of Commercial Intelligence. Marketing development is making progress and the work of this Department is highly esteemed amongst small-holders. Co-operation is also progressing slowly, in some districts more than others.

It was a great pleasure to renew acquaintance with many old friends in Ceylon and to discuss with them again their work. It was also very useful to me to see the developments in agricultural research which have taken place during the past ten years and to appreciate that its importance is becoming more

and more recognised as the years pass and the results of the research workers are applied to agricultural practices. This application of research results in agriculture is difficult, but considerable efforts have been made in Ceylon by the provision of advisory services and by education and propaganda to interest all, including small-holders, in the measures which can be taken to effect the improvement of agricultural practices. Much still remains to be done, but definite progress is being made.

F. A. STOCKDALE.

Colonial Office,

6th February, 1939.

APPENDIX.

ITINERARY.

1938.

6th January.—Left London.

7th January.—Embarked on P. & O. s.s. *Comorin* at Marseilles.

9th January.—At Malta. Discussions with Captain Ramage.

23rd January.—At Colombo. Discussions with Director and Deputy Director of Agriculture.

28th January.—Landed at Penang. Met by Adviser on Agriculture, Malaya. Visited copra stores in Penang, Batu Kewan Estate, Bukit Mertajam Agricultural Station, Tassek Tanjong Irrigation Scheme and Bukit Merah Padi Test Station.

29th January.—Visited United Patani Estate and then proceeded to Alor Star visiting rice mill and Telok Changai Padi Station en route.

30th January.—Visited rice mill and Village Market and Fair at Anak Bukit, co-operative padi store, Gajah Mati Agricultural Station and Langgar Padi Test Station.

31st January.—Visited Titi Serong Padi Station, Padi Test Stations and Government Rice Mill at Bagan Serai. Stayed at Parit Buntar.

1st February.—Inspected Briah Padi Test Station and headworks of Krian Irrigation Scheme at Bukit Merah. Then to Taiping. Discussions with Resident and after inspecting experimental area on lands which had been worked for tin proceeded to Kuala Kangsar. Visited the Agricultural Station there.

2nd February.—Visited Kuala Kangsar Padi Station and then proceeded to Ipoh. Visited coconut oil mill, tapioca factory and the Ipoh Dairy Scheme with the District Officer. Proceeded to Telok Anson.

3rd February.—At Telok Anson. Inspection of the Sungei Manik Irrigation Scheme and in afternoon visited Cicely Estate.

4th February.—Proceeded to Kuala Lumpur and visited the Sultan Idris Training College en route.

5th February.—Visited the Rubber Research Institute and discussed with the officers concerned the work of the rubber technology and pathological divisions. In evening, discussed the co-operative movement with the Registrar of Co-operative Societies.

6th February.—At Kuala Lumpur. Left with Adviser on Agriculture by night mail for Kelantan.

7th February.—Detrained at Kuala Krai and motored to Kota Bharu. Visited paddy, rubber and coconut cultivations.

8th February.—Inspected Kota Bharu Experiment Station, Bukit China and Labok grazing reserves, site for new agricultural station at Melor, Bechok Agricultural Station and Pasir Mas Agricultural Station.

9th February.—To Tumpat. Visited paddy growing areas and subsequently Messrs. Bonstead's rice mill and copra and rubber godowns. Visited flood prevention scheme and rubber factory at Lundang. Reception by H.H. the Sultan of Kelantan at Nilam Pari Palace.

10th February.—To Besut in Trengganu. Inspected Irrigation Scheme and Pasir Pueth Padi Test Station. Returned to Kota Bharu.

11th February.—Left by motor for Kuala Krai and thence by train to Kuala Lipis.

12th February.—Inspected Kuala Lipis Agricultural Station, Raub Padi Test Plot, Raub Agricultural Station and then proceeded to Fraser's Hill.

13th February.—At Fraser's Hill. Visited the Fraser's Hill Dairy Scheme.

14th February.—To Kuala Lumpur. Visited the Research Laboratories of the Department of Agriculture.

15*th February*.—Visited Klang Coconut Station, pine-apple cultivations and in afternoon visited again research laboratories of the Department of Agriculture at Kuala Lumpur. Dinner given by the Director of Agriculture.

16*th February*.—Inspected the Central Experiment Station and the Agricultural School at Serdang.

17*th February*.—Inspected work of Asiatic rubber instructors, Rajagiri, Golconda and Bukit Rajah Estates. Dinner given by Director of Agriculture.

18*th February*.—Visit to the Experiment Station of the Rubber Research Institute, the Forest Research Institute and Wardieburn Estate. In evening attended reception by the Director of the Rubber Research Institute to staff of Institute and representatives of the rubber industry.

19*th February*.—Discussion with Federal Secretary and Adviser on Agriculture of the Tea Regulation Scheme and the position of Malaya in relation thereto. Visited laboratories of the Soils and Botanical divisions of the Rubber Research Institute. Reception by Director of Agriculture to staff of the Department of Agriculture.

20*th February*.—Left by car for Malacca. Visited Cheras Agricultural Station, Sungei Mahang Estate, Rembau Agricultural Station and Kendong Padi Test Station. Interview with Dr. Chapman, Chemist to Messrs. Guthries.

21*st February*.—Inspected Palan Gadong Padi Station, Sungei Udong Agricultural Station and the Malacca Farm School.

22*nd February*.—Visited Padi Test Station at Jasin, and subsequently the Agricultural Station and Padi Test Station at Muor. Inspected coastal areas of coconuts affected by inundations of salt water and visited a portion of the Sembong-Senggarong Drainage scheme.

23*rd February*.—At Singapore. Visited godowns belonging to the Eastern Asiatic Company and inspected samples of Far Eastern copra, pepper, etc. Discussed the question of copra grading. Discussions with His Excellency the High Commissioner on dioramas for the Glasgow Exhibition, Tea Restriction and agricultural matters generally. Visited pine-apple factory and the Singapore Dairy.

24*th February*.—Visited Pine-apple Experiment Stations in Singapore and at Kota Tinggi in Johore. Proceeded to Malacca to visit Dunlop Plantations with Mr. Wiseman, Dr. Haines and the Director of the Rubber Research Institute.

25*th February*.—Visited Ladang Geddes Estate in Negri Sembilan.

26*th February*.—Visited Paya Lang Estate in Johore and proceeded to Kuala Lumpur. Discussions with Conservator of Forests and Director of Veterinary Services.

27*th February*.—Proceeded by car to Cameron Highlands.

28*th February*.—Visited estate and holdings devoted to the cultivation of fruit, flowers and vegetables. Major Doyle's establishment and the Bole Tea Estate. Inspected area selected for Fruit Experiment Station.

1*st March*.—Visited Sungei Palas Tea Estate and other holdings. Inspected the Agricultural Experiment Station, Tana Kota.

2*nd March*.—Attended meeting of Cameron Highlands Society to discuss prospects of development in the Highlands and then proceeded to Kuala Lumpur.

3*rd March*.—At Kuala Lumpur. Attended meeting of the Agricultural Advisory Committee in the morning and had discussions with the Adviser on Agriculture and the chief Field and Research Officers of the Department of Agriculture on agricultural matters generally in the afternoon. Left by night mail for Singapore.

4th March.—Discussions in Singapore and left in afternoon by s.s. *Plancius* for Batavia.

6th March.—Arrived at Tandjong Priok and proceeded to H.M.'s Consul General in Batavia. Visited Exhibition staged by Health Department.

7th March.—Interviews and discussions at the Departments of Economic Affairs and of Internal Affairs. Arrangements of final details of tour programme with Dr. Beumée. Interview with Mr. C. van den Bussche, Vice-President van den Raad voor Nederland Indies acting as the Governor-General's Deputy during his absence on tour.

8th March.—Visit to Pasir Minggoe Fruit Experiment Station. Interviews with Dr. Kramer, President of the General Agricultural Syndicate, and Mr. L. G. C. van der Hoek, the Governor for West Java.

9th *March.*—Left by car for Buitenzorg. Visited Experiment Station for West Java (rubber and tea). Discussions with the Director and the Chief for Rubber Research.

10th March.—At Buitenzorg. Visited Botanic Gardens and Agricultural College. Discussion on agricultural education with Dr. G. A. de Mol, Chief of the Agricultural Education Service.

11th March.—Visited Government Soil Institute, Botanical Research and Agricultural Experiment Station comprising divisions for annual crops, perennial crops and statistics. Also visited the Phytopathological Institute.

12th March.—Visited Pondok Gedah Estate and then proceeded by car to Goolpara Estate.

13th March.—Proceeded from Goolpara Estate to Bandoeng. Visited padi cultivations.

14th March.—Visited the Government Cinchona Estate at Tjinjiroean and Pasir Junghuhn tea estate. Visited cultivations en route to Garoet. Discussions on rubber roadway work with Mr. Orte.

15th March.—Study of peasant agriculture with Mr. Wirte of the Agricultural Extension Service. Visit to Farm School and subsequently to European-owned dairy near to Bandoeng. Visit to Tangkoban Prahoe. Proceeded in afternoon to Pemranoekan and Tjiasem Estates owned by the Anglo-Dutch Company.

16th-18th March.—Visits to Estates belonging to the Anglo-Dutch Company including cultivations of tea, rubber, kapok, pepper, coffee, cinchona, cacao, aleurites, sisal, tapioca and rice. Visits were also paid to rice colonization scheme and to teak reafforestation areas.

19th March.—Motored to Tjampek and thence to Cheribon after visiting co-operative societies and studying credit facilities provided for smallholders.

20th March.—Cheribon to Poerwokerto. Visited the Health Centre at Poerwokerto.

21st March.—Visited village health units with Dr. Hydrik and Dr. de Bruys Kops. Left by train for Djokjakarta.

22nd March.—Visited peasant agriculture around Djokjakarta. Farm school, school gardens and the Fruit Experiment Station.

23rd March.—Visited archaeological remains at Borobudur and Premboean and Klaten Tobacco Experiment Station. Left by afternoon train for Soerabaya.

24th March.—Visited Sugar Experiment Station at Pasoeroean and thence by car to Malang.

25th March.—Malang. Visits to Agricultural School and the Fruit Experiment Stations. Also control work against Armillaria root disease of oranges.

26th March.—Visits to the experiment Station for East Java (coffee and rubber) and Soember Asin Coffee Selection Estate.

27th March.—Malang. Discussions with Dr. Muller—Phytopathologist—on control work against citrus root disease and potato breeding work designed to produce types of potatoes resistant to Phytophthora leaf disease.

28th March.—Left in morning for Soerabaya and thence by night mail for Batavia.

29th March.—Discussions with the British Consul-General. Interviewed the Director of the Department of Economic Affairs and attended conference arranged by the General Agricultural Syndicate to consider international co-operation in rubber research. Attended lunch given by the General Agricultural Syndicate.

30th March.—At Batavia with the British Consul-General. Left at noon by the *John de Witt* for Colombo.

1st April.—At Singapore. Visited the Botanic Gardens with the Acting Director.

2nd April.—At Belawan. Visited Medan, Messrs. Harrisons and Crosfields and the A.V.R.O.S. Experiment Station.

3rd April.—At Sebang. Visited smallholders' cultivations and forest clearings.

6th April.—Arrived at Colombo. Inspected work of Ceylon Rubber Research Scheme at Agalawatte and Dartonfield. Left by night mail for Nuwara Eliya.

7th April.—At Nuwara Eliya. Discussions with H.E. the Governor. Inspected work of Tea Research Institute at St. Coombs, Talawakele and in afternoon visited Hokgala Gardens with H.E. the Governor.

8th April.—Discussions at Nuwara Eliya with H.E. the Governor, the Minister for Agriculture and Lands and the Director of Agriculture.

9th April.—Left by car for Peradeniya. Inspections at Headquarters of the Department of Agriculture—Library, Mycological, Entomological, Veterinary Laboratories, Agricultural School and Experiment Station.

10th April.—Royal Botanic Gardens, Peradeniya. Horticultural work and offices of Paddy Officer, Propaganda Officer and Divisional Agricultural Officer (central). Garden party in afternoon given by the Director of Agriculture to meet officers of the Department of Agriculture.

11th *April.*—Visits to Nalanda and Dambulla Experiment Station, Stock Farm at Polonnaruwa, Minneriya Colonization Scheme and then to the Coconut Research Scheme at Bandirippawa via Kurunegala

12th April.—Inspection of work of Coconut Research Scheme at Bandirippawa. Discussions with members of the Schemes Executive Committee. To Colombo. Discussions with Registrar-General and Director of Commercial Intelligence, Marketing Commissioner and Registrar of Co-operative Societies.

13th April.—At Colombo. Sailed in afternoon by P. & O. *Naldera.*

27th April.—Called at Malta. Interviewed H.E. the Governor, the Acting Lieutenant-Governor and the Director of Agriculture on agricultural undertakings in Malta.

29th April.—Disembarked at Marseilles and took the P. & O. express to London.

30th April.—Arrived at Victoria at 3.40 p.m.

(16065—29) Wt. P3747—4247 500 5/39 P. St. G. 373