

THE New Guinea Agricultural Gazette.*

Vol. 5.

JUNE, 1939.

No. 2.

CONTENTS.

ORIGINAL ARTICLES.

	PAGE.
COPRA INFESTATION BY <i>Ephestia cautella</i> , Wlk.— John L. Froggatt, B.Sc., Entomologist, and F. O. Moody, Agricultural Inspector and Instructor	2
OIL PALM PLANTING IN SUMATRA, NETHERLANDS EAST INDIES— G. H. J. Van der Sluys, Manager, Ralabang Estates, New Guinea	6
SUGGESTIONS FOR THE IMPROVEMENT OF NEW GUINEA COPRA—BAGGING AND SHIPMENT— E. Caulfield Kelly	10

REPORTS.

RÉSUMÉ OF DEPARTMENTAL ACTIVITIES (Year ended 30th June, 1938)	12
PATROL TO KUNUA AND HAHON, KIETA DISTRICT— C. F. R. Gilbert	40

SELECTED ARTICLES.

FROM PLANTER TO PRIME MINISTER— Reprinted from <i>The Planter</i> , Vol. XIX., No. 10, October, 1938, page 489	42
COCKROACHES—DISEASE TO HUMANS— <i>Straits Times</i> , 27th December, 1938	43

* The following numbers have been issued—

Vol. 1, No. 1.—October, 1935.

Vol. 2, Nos. 1, 2 and 3.—January, October and December, 1936.

Vol. 3, Nos. 1 and 2.—April and December, 1937.

Vol. 4, Nos. 1, 2, 3 and 4.—January, April, July and December, 1938.

Vol. 5, No. 1.—March, 1939.

COPRA INFESTATION

BY

Ephestia cautella, Wlk.

(John L. Froggatt, Entomologist, and
F. O. Moody, Agricultural Inspector and Instructor.)

A recent occurrence of infestation by *Ephestia cautella*, Wlk. in this Territory, although known elsewhere, is of relatively unusual occurrence, in that the whole of the outside of the bags was smothered in webbing.

The Director, Imperial Institute of Entomology, London, advises that such occurrence as above has been recorded, but only when the infestation has been very heavy.

Life History and Habits.

The eggs of this moth are laid either on the bags or on the copra, the caterpillars, in the former case, entering through the bags onto the copra.

Corbett¹ has proved that the grubs of this moth mature quicker on mouldy copra, kept moist, than on good copra kept moist—on such copra kept dry, the life-cycle period was prolonged in each case, but was longer on the good copra—the minimum period of life-cycle was 22 days. Well dried copra is not considered good food for *Ephestia* caterpillars.

The infestation of copra by this moth, as well as by other insects, is closely associated with the moisture content of the finished product; inferior quality (mouldy and under-dried) copra is always more subject to attack than well dried and clean copra. As the copra dries out, so does the insect infestation decrease after a certain moisture content is reached.

Infestation in the Territory of New Guinea.

Considerable attention has recently been paid to infestation of copra by *E. cautella*, more especially in Australia, and the subject of the sources of infestation were gone into in detail in this Territory, by both writers, separately and conjointly.

As a result of these observations, it was evident that the initial infestation was occurring, in very many instances at least, in the storage sheds on plantations, although this was probably aggravated to a certain extent in depot sheds where the period of storage is prolonged.

Plantation Conditions.

On plantations, it has been, and, to a certain extent, still is, the practice to bag the copra the day after it is taken off the drier. This has been proved to be a bad practice, as the copra dries out for a further period of four to five days after removal, and if bagged and stacked immediately, will sweat in the bags. This only encourages insect infestation.

(¹) Bulletin No. 20, Science Series, S.S. & F.M.S., Department of Agriculture.

A better practice, and one that is now in more general use, is to heap the copra in a well ventilated but weather-proof shed for several days before bagging, the copra in the heap being turned over each day; this obviates sweating, and the copra of poor quality can be removed by picking over before bagging.

Factors Affecting Infestation.

It is an established fact in this Territory that well dried copra (i.e. with a moisture content of not more than 5%), will remain in good condition and free from insect infestation for long periods, whereas under-dried copra is liable to infestation soon after leaving the drier.

Contributory causes to infestation may be due to:—

1. Storage of copra in non-weather-proof sheds, resulting in bags becoming wet through rain.
2. Sweating of copra in sacks.
3. Loading from plantation to vessel, and from vessel to depot store in rain, or in leaking lighters, resulting in "wet bags".

In each case, the copra becomes damp and moulds supervene—a condition favorable to attack by various insects. Such copra, unless thoroughly re-dried, will be found infested in the stack, and leads to surrounding bags becoming infested.

4. There are parts of the Territory where owing to lack of anchorages, vessels loading copra at plantations have to lie off and send in lighters, often for appreciable distances. Owing to bad weather, especially during certain seasons, the vessels are unable to load and have to leave the copra behind, resulting in prolonged storage of up to three to four months on the plantation. Where predisposing factors exist, this condition lends itself to aggravation of the trouble.

5. Plantations are known in this Territory, where the mountain range is close to the boundary, and with spurs forming deep gullies that act as a funnel for a definitely cold land breeze at night even right onto the beach. Where stored copra is subjected to this cold wind, condensation of moisture will occur on iron walls and roofs which may drip onto copra the following morning, again assisting mould formation and insect attack. Wherever copra is subjected during storage to cold, humid changes in climatic conditions, a similar condition of copra will ensue.

6. Storage of copra and rice (especially) in the same or adjacent sheds.

7. Sacking of copra in old bags contaminated as a result of carrying in green coco-nut "meat" from the plantation or which have been used for sacking dried food products (i.e. rice or "sharps").

Consideration of the Shipment in Question.

In the case in question, the copra had been stored on the plantation in an old copra store made of native materials, and varied in age up to six weeks.

When unloaded at Rabaul, a very thin film of webbing was observed on the outside of the bags and, although the copra had been slightly under-dried when bagged on the plantation, it was not of markedly poor quality. There was,

however, a quantity of frass and webbing on the copra, and numerous caterpillars were crawling over the outside of the bags. Examination of the copra showed that the "rind" of the copra had in some cases been eaten off, many pieces showing that the grubs had fed into the heart of the copra.

The advice of the writers was asked for, and immediate isolation and fumigation with hydrocyanic gas in the Government fumigator was recommended. The copra was shifted into a small isolated shed, and two unsuccessful attempts were made to fumigate in the stack in the shed. Ultimately, the consignment was treated in the departmental fumigation chamber with satisfactory results. Stacking in the fumigator was arranged in lines on dunnage and with dunnage between the two layers of bags, and space between the lines. This consignment of copra went approximately fifteen bags to the ton.

Measure for Minimization.

To carry out an efficient campaign, throughout the Territory, against this pest under existing conditions, measures would have to be undertaken in—

1. Plantation storage sheds.
2. Holds of inter-island ships.
3. Depot storage sheds.

1. It is evident from previous observations that fumigation of most, if not all, plantation copra storage sheds is impracticable from an economic point of view.

Whenever a copra shed is empty, however, it can be thoroughly cleaned out and sprayed with kerosene. This would kill a large proportion of the carry-over grubs, chrysalids and moths. Cases are on record, where this is done with excellent results.

Rice should never be stowed in the copra shed, as the former is subject to very heavy infestation by *E. cautella*.

2. If preventive measures were carried out generally on plantations, fumigating of ships' holds would probably only need to be done where rice already infested with the pest had been transported.

3. *Depot Storage Sheds.*—The practice of storing rice and copra in the same shed should be discontinued, as the former is only increasing the moth population for infestation of the copra.

Whenever a shed is sufficiently empty to enable a general cleaning out to be done, this work should be thorough; old copra and copra waste lying under "duck-boards", or other dunnage should be cleared away, and all beams, &c., broomed and sprayed.

Fumigation on a scale necessary to control the pest would be too costly with copra at its present low value. Provided that the sheds could be closed for 24-36 hours, and rendered sufficiently gas tight, calculations on the basis of quantity of copra through depot sheds in Rabaul, and the quantity of powder fumigant required, show that the cost of material would be about 1.10d. per ton of all copra handled during the year. The cost of sealing the shed would be additional.

A more feasible scheme, if such treatment is desired, is to build a special fumigating chamber to treat incoming copra that shows a sufficient degree of insect infestation to warrant the cost of fumigation, combined with thorough cleaning out of the storage sheds whenever practicable.

Investigations have been carried out by the School of Science and Technology of the London University on white oil-pyrethrum spray⁽²⁾ for control of *Ephestia cautella* in dried food products stored in warehouses at the Port of London. On account of the spray, special apparatus is required for atomizing the fluid, but, after a consideration of existing conditions, some such method appears to offer possibilities for the treatment of sheds in this Territory, and should be worthy of close investigation.

In reference to the "Technique against caterpillars," Dr. Potter states (in reference to dried fruits):—

The method is mainly useful in stopping the spread of infestation and preventing re-infestation.

The larvae of the two species of moths only come out of the fruit and expose themselves to the action of sprays when they are fully grown. Spraying is therefore of no use for goods infested with the early stages of the insect. In addition goods infested with fully grown caterpillars cannot be completely cleaned. This can only be done by means of fumigation.

Spraying is used to prevent infestation in three ways. First, when infested goods are stored next to clean goods the fully-grown larvae may crawl out and infest the clean goods. By spraying the infested goods most of the wandering larvae are killed and so the spread of infestation is prevented. Secondly, when infested goods are stored in clean premises, they are sprayed to kill the full-grown wandering larvae and these insects do not reach the premises where they normally would over-winter. Spraying in this instance prevents the possibility of clean goods being infested by moths resulting from these caterpillars. Thirdly, when goods infested with caterpillars are taken away either to be fumigated and returned or to be replaced by clean goods, it is necessary to spray the site after the goods have been removed. In this way, larvae that have dropped off during the process of removal are killed. If this is not done the insects left behind are liable to infest any goods placed on that site.

(2) An account of the constitution and use of an atomized white oil-Pyrethrum fluid to control *P. interpunctella*, Hl., *E. cautella*, Hl., in warehouses by C. Potter, B.Sc., *Annals of Applied Biology*, XXII, No. 4—1935.

OIL PALM PLANTING IN SUMATRA.

(Netherlands East Indies.)

By G. H. J. Van der Sluys.

The oil palms (*Elaeis guineensis*) which are now being cultivated with particularly promising results in the Netherlands East Indies, but especially in Sumatra, are all grown from seed. The history of the oil palm there dates back as far as 1848.

In 1848, the Botanical Gardens at Buitenzorg (Java) received four young palm trees of the variety *Elaeis guineensis*—two from Bourbon and two from the Hortus Botanicus at Amsterdam. Reports in 1858 stated that the four plants were growing vigorously at Buitenzorg, bearing abundant fruit, which was distributed freely.

The oil palms which are to be found on the various plantations in Sumatra to-day are all grown from the seed of these four trees and their descendants. It is a remarkable fact that these oil palms show very uniform type, whereas recent imports, from South Africa for instance, have shown a mixture of very different types.

The Government in Java started experiments in 1859, and planted a few acres with oil palms in the Residency Banjoemas (Java) and at Palembang (Sumatra). The official report given in 1864 stated that the experimental planting of *Elaeis guineensis* had been a complete success, and it can be said that the palm tree grows as well in Sumatra as in its native country, Africa, if not better, since it commences to bear fruit in its fourth year, whereas in Africa, it takes from six to seven years.

The history of the oil palm plantations in Sumatra begins in 1910. The Belgians, especially Mr. Hallet, must be credited with being the first to plant large areas with oil palms in the Far East.

Knowing all about the oil palms in West Africa, and seeing how exceedingly well the ornamental trees in Sumatra were growing, Mr. Hallet was convinced from the beginning that oil palms in Sumatra would be a success.

In 1911 the first areas were planted, and a few years after, before any practical results were obtained, over 6,000 acres had been planted, so great was the confidence of the promoters in the new industry.

The Great War brought further extensions to a standstill at the end of 1914, but in 1918 a total area of 8,500 acres had been planted. At the beginning of 1924 over 30 estates in Sumatra had been developed and planted with fine young oil palm trees, an area of 35,000 acres being in cultivation. In 1924 about 10,000 acres were producing. As the soil and climate of Sumatra, however, are very suitable for oil palm growing, these figures have increased considerably since that date.

Practically the whole of the present area planted, over 150,000 acres, is uniformly planted with the Deli-type, a good specimen of *Elaeis guineensis* Jacq, var. *dura*, whilst a fairly complete collection of other varieties is at hand for further selection work at the Experimental Station at Medan (East Coast of Sumatra).

The Sumatra estates are being scientifically developed upon results obtained at the east coast experimental station near Medan, world-famous under the title derived from the initials of its Dutch name, A.V.R.O.S., and with the advice of experts who are at the head of their profession. Evidence to date serves to prove that cultivated palms give a higher production than their indigenous relatives in West Africa and that it is possible for Sumatra palm oil to equal in quality the best African palm oil on the market. The aim of all connected with the industry, with its great prospects in the Netherlands East Indies, is to standardize the entire Sumatra output on a best-quality basis.

On the majority of Sumatra estates the oil palm trees are planted 30 feet x 30 feet apart, giving for the first four or five years an opportunity to plant a catcherop. Profitable results have been obtained with Robusta Coffee planted out at a distance of 8 feet x 8 feet. This catcherop shows no unfavorable results, and does no harm to the young trees, if carefully planted and not kept for a longer period than five years.

Developing.—The developing of an oil palm estate in Sumatra is carried out more cheaply than rubber, tea, sisal or tobacco. It takes less time and labour. After the forest is felled, burned and cleared (big trees can be left to rot away), a good straight lining of say 30 feet x 30 feet spacing should be started at once. This wide spacing has the effect of developing stout and short stems, thereby facilitating harvesting of the crop besides being more productive. Planting 30 feet x 30 feet on triangular system requires 56 trees per acre.

Fresh seeds are germinated in nurseries, which usually takes about four to five months after laying out, but may take eight months and longer. To hasten germination seeds are sometimes soaked in hot water for a few days, bringing the water to a temperature of about 115 degrees Far., thrice daily. Soaking the seed in sulphuric acid has been done, but does not give entire satisfaction.

When strong young plants have reached about 2 feet in height in the nurseries, they are planted out in suitably made holes of 2 feet x 2 feet x 2 feet in size. The young palm trees may be transplanted to the fields just as successfully when they are six months old, as when they are one and a half years, even two years old, so long as sufficient care is taken in transplanting. Large nurseries must be prepared during the first year of developing the estates.

The length of time the plants are to remain in the nurseries and the distance between the plants in the nurseries depends upon the season when planting out in the fields is to take place.

The upkeep of an oil palm estate is simple. When the plants have once become established, there is practically no trouble, as no root disease threatens the oil palms and very few pests are known so far. When no catcherop is planted the usual cover crops, such as *Centrosema*, *Calopogonium*, *Pueraria javanica*, &c., are used. Some estates have four or five rows of *Tephrosia candida* in between the young palms, enriching the soil and keeping it covered. The oil palm thrives in a hot, humid climate and low-lying alluvial soil. It requires similar climatic conditions to cacao and a somewhat lower rainfall than the coco-nut palm.

Palm Oils.—The preparation of palm oil is carried out in a number of different ways, the methods employed depending upon the product sought. A low free fatty acid basis is demanded of oil that is to serve as a basis for edible

fats. That oil with a low free fatty acid can be produced has been shown through many experiments in the laboratory, and in some up-to-date factories of the best oil-palm estates in Sumatra.

Before the war it was proved that palm oil with a low fatty acid basis could be adapted for the manufacture of edible fats and it was found that this fat was especially good for the preparation of margarine. The real pure margarine is no longer looked upon as the poor man's makeshift for butter in Europe; it is a good, wholesome, nutritious food.

The three main steps in the preparation of palm oil are heating, depulping and pressing. Whole bunches are transported, with as little bruising as possible, to the factory soon after harvesting. After the heating and drying of the bunches, the fruits are removed from the bunches by machinery. After this they are heated again, and pressed for the first time, depulped, heated and pressed from the pulp.

The structure of a ripe fruit may be roughly divided into pericarp, shell and kernel. The outer layer of an oil palm fruit represents the pericarp or pulp, composed of cells which at maturity contain the pericarp oil. The shell has no known commercial value, and its presence in a fruit means so much waste product. The centre represents the kernel, which yields the commercial kernel oil, and is the tissue that nourishes the germinating embryo.

The fruits on the oil palms in Sumatra contain an average of about 60 per cent. pericarp and 8 per cent. kernels, and the oil palm in Africa contains about 40 per cent. pericarp and 17 per cent. kernels.

The percentage of pericarp in the variety planted in Sumatra and F.M.S. is 50 per cent. higher than the average figure from Africa, but the percentage of kernels is only half that which has been obtained in Africa. Since the total value of palm oil from the pericarp is far higher than that of the kernels, Sumatra, or, in general, the cultivated oil palm, has a distinct advantage in this respect.

Very good results have been obtained in Malaya and the F.M.S. and, undoubtedly, there are districts in New Britain and on the mainland of New Guinea with climatic and soil conditions comparable to those of Sumatra oil palm plantations. Experiments in Papua prove that the oil palm will come into bearing just as quickly as on the east coast of Sumatra, Malaya and the F.M.S.

It is a crop, therefore, that is worthy of consideration by companies which are prepared to enter upon its cultivation on an extensive scale and invest a large capital to secure an up-to-date factory for the valuable produce of the oil palm.

Oil palm planting should yield a rich and adequate reward if a bold policy of rapid and extensive plantations is advanced, supported by the necessary capital to take advantage of the benefits to be derived from a large unit of mill-plant.

Cost.—The cost of planting and developing a large oil-palm estate of, say, 3,000 H.A., including all necessary buildings, factory and plant, can be estimated at £100 per hectare.

Oil palms from the 5th to the 10th year yield, when planted at the proper distance, 100 pounds (Dutch pounds) of fruit per tree, the fruit being separated from the bunches.

The separated fruit produces 60 per cent. pericarp and 8 per cent. kernel; the pericarp contains 40 per cent. oil, the kernel 50 per cent. oil. Taking 100 pounds of fruit per tree and the above percentage, it will appear that young oil palms, coming into their fifth and sixth year, produce per acre per annum—

Pericarp oil	..	..	..	..	..	0.535 tons.
Kernels	..	..	..	..	..	0.178 „

Mature oil palms should yield one ton of oil per acre, plus $\frac{1}{3}$ ton of kernels, and the cost per ton f.o.b. should be £15 with freight, &c., at £6 per ton, or total cost will be £21 per ton.

Experience in Sumatra shows that profits range from £7 per acre for five year old palms to £20 an acre, when in full bearing. Estimating the returns at £37 per ton for palm oil and £19 per ton for palm kernels (average price on a number of years), the profit per acre should rise from approximately £6 per acre in the fifth year after planting, to £16 per acre in the tenth year. On a capital expenditure of £40 per acre, this profit shows a return of 15 per cent. in the fifth year, rising to 40 per cent. in the tenth year.

SUGGESTIONS FOR THE IMPROVEMENT OF NEW GUINEA COPRA—BAGGING AND SHIPMENT.

By E. Caulfield Kelly.

Whilst the quality of copra must necessarily be a first consideration at all times, the manner in which it is presented for sale in the open market can seriously influence the decisions of purchasers and appraisers, as regards price and grade.

Unfortunately, in New Guinea we have several factors which militate against the general appearance of a shipment of copra when it reaches the markets, and these, although in themselves they may be relatively unimportant as regards the actual quality of the product, serve to create a prejudice, at first sight, in the eyes of an inspecting purchaser or his valuer.

One of the principal of these factors is the bag or container in which the product reaches the market. Foul, filthy, patched and semi-rotten second-hand bags, with, frequently, one or more half-obliterated brands, designating previous contents, are all only too familiar sights when copra is being loaded for overseas at New Guinea ports, and suggest an appearance of neglect and lack of care for their produce on the part of the producers.

The spectacle of wharfs littered with what had been good produce, the contents of burst or rotten bags which have become torn in the ship's slings, and is being trampled upon by stevedores and crushed by trucks and, perhaps frequently, sodden by showers of rain, is unattractive and ugly, whether at the port of shipment or discharge, and could easily bias a consignee against a whole shipment on first appearance alone.

The musty and rancid odour of foul bags, emanating from the warm hold of a ship discharging, could also prove detractive to the general appraisalment of a shipment, however good its quality on the plantation, and human nature is only too prone to take a possibly undue regard of such factors as slovenliness and outward appearance.

The loss annually to the exporting firms in this country must be enormous. Copra shipped in second-hand or half-rotten bags will, obviously, not handle easily; native labourers have little or no regard for the property which they load and unload from ships and depots; hook-torn and burst bags therefore result, and maltreatment and destruction of the produce is inevitable.

At Rabaul concentration depots, when local ships are unloading, it is quite common to see the holds of the ships covered to a depth of several inches with loose copra from broken bags, and, as the grades in such cases are so hopelessly mixed as to render separation quite unworthwhile, copra inspectors in the course of their duty are reluctantly compelled to request that all such sweepings, when re-bagged, be submitted in the lowest grade of the contained copra. This frequently results in a loss to the exporter of as much as £1 per ton over the price paid by him to the producer, for a considerable proportion of the sweepings affected.

Many overseas freighters also refuse to accept torn or damaged bags and, here again, the exporter is subject to considerable expense in the course of a year for re-bagging costs.

In the interests of the industry, therefore, sound, new and clean containers should at all times be used and, in their own interests, the exporting firms

should cause all second-hand bags to be either destroyed or exported to rag dealers or paper manufacturers, rather than sold to plantations for the export of produce.

It is the practice, too, on many plantations in New Guinea to use new bags to carry freshly-cut coco-nut meat about the plantation for a period, and subsequently to dry out the bags, and ship copra in them. This practice is supported by the contention that bags are thus stretched, and will eventually hold more copra for shipment than new bags. A further contention—a rather parsimonious one—is that a certain amount of residual oil is left in bags so used, and this enhances the value of a shipment on the scales.

Against these considerations, however, such factors as the dirty appearance of the bags when finally shipped, the destruction of the fabric by oil and water, and the risk of fire by spontaneous combustion, are all lost sight of.

If new bags were used for shipment the additional expense to the planter could not exceed the cost of one more sack per ton of copra, and this would be considerably more than offset by the general appearance of his shipment, and its consequent enhanced value in the eyes of the consumer.

In exporting countries like Ceylon, Malaya and the Dutch East Indies, new bags are invariably used for shipment. Ceylon producers split their nuts at the drier, and dry in the half shell, so that the necessity for transporting green meat in bags does not exist. The bulk of copra exported from Malaya and the Dutch East Indies is made by native small-holders, and these employ baskets and such receptacles rather than foul new bags before shipment. The produce of these countries reaches the markets in a clean and attractive condition, and the whole appearance of their produce is reflected in the preferential price which it fetches.

It stands to reason, in the case of any commodity, that an article which is presented for sale in an attractive covering will be more in demand than a similar article presented in a clumsy or nondescript exterior, whatever the relative qualities of the contents. Fortunes are made in every walk of life by advertising experts, whose work lies chiefly in "window-dressing" and attractive presentations of the goods they advocate, and it is only reasonable to suppose that this applies in the case of copra.

Storage in the principal New Guinea concentration centres is carefully attended to by the exporting firms, and the greatest care is taken by the Department of Agriculture to ensure the best possible conditions of stowage in overseas vessels. Deadweight cargo, such as phosphates and concentrates, is heavily dunnaged with wood and canvas before copra is loaded on to it; the produce is always protected from contact with the sides of the ship by wooden batons and iron stanchions; hatch beams and coamings are draped with hessian to protect the bags.

It therefore remains for the producer to add his quota towards the general improvement in appearance of his produce on the markets by subscribing to the suggestions put forth above.

Even legislation might reasonably be introduced to provide for the shipment of produce in new bags, as a step towards raising the market status of the primary industry of the Territory; but, in the meantime, the local firms which purchase copra for shipment abroad should, in their own interests, insist on produce being offered for sale in sound and clean sacks.

RÉSUMÉ OF DEPARTMENTAL ACTIVITIES.

(Year ended 30th June, 1938.)

Agricultural Products.

Coco-nuts.—During the first quarter of the year, the ill-effects of the eruption were still noticeable, but there was rapid recovery in plantations and native groves after the nor-west rains set in, with two or more exceptions.

Part of the damage was due to the accumulations of pumice weighing down the palm leaves, which, in some cases, was responsible for the collapse of the crowns, but where this did not happen, many of the fronds resumed their natural position, and the only loss was in the destruction of flowering spathes and immature nuts.

The greatest damage was caused by the cloud-bursts subsequent to the eruption, causing rushing temporary rivers which carried away some thousands of palms from Kurakakaul and Wunawutung Plantations. On the other hand, some plantations received a slight benefit, as chlorotic palms lost their sickly yellow colour and became a healthy green from some beneficial element in the pumice, though, on the whole, analysis indicated the presence of few elements of value to plant life. Pumice was the most important element present, while nitrogen and phosphates were low. The pumice also checked the growth of the noxious grass "Kunai" for a short time, which was of temporary benefit to the palms. An investigation of the damage done to the palms was made by the Economic Botanist, who reported that, with the exception of two or three plantations, the damage was mainly of income, and permanent loss was comparatively small.

On the south coast, Kokopo-road, large numbers of native coco-nut groves and whole villages were completely obliterated and covered to a great depth with pumice.

Coco-nut plantations in other parts of the Territory have had normal conditions, but production declined to a small extent when copra prices dropped, due to a slight decrease in the production of the native article. Plantation production naturally remains more stable as planters have their obligations to meet, whereas natives can be independent of their copra, which is mainly produced for the purchase of luxuries, and they will allow their nuts to waste, rather than go to the little trouble of curing copra when prices are low.

There is strong evidence that in some districts of New Guinea natives do select seed nuts for planting, having regard to the rough measurements of yield, size, weight and thickness of husk.

Fresh Coco-nuts (for the fruit market).—There has been little or no expansion in this side of the coco-nut industry, distance from market being the most important factor in militating against its development. There is but one man engaged in this business, and he acts as a middle-man, buying from a planter and giving slightly more than the ruling price for coco-nuts used in copra-making.

Desiccated Coco-nut.—Two only of the three desiccating mills have been working full time, producing 1,579 tons, valued at £73,423.

Coco-nut Peelings.—This is really the offal from the desiccating factory, and being of too inferior quality, even for passing as "trade" copra, approval is given for its export under the designation "coco-nut peelings" (402 tons exported of a value of £1,759).

Coir Fibre Mill.—The mill for the preparation of this product has been erected and has turned out a fine-quality fibre. It is superior to that imported from Ceylon, and has found a ready sale to Chinese upholsterers. Certain adjustments have yet to be made to the machinery before the company owning the plant is ready to prepare regular shipments to oversea markets. An interesting fact regarding the preparation of the coir fibre is that husks which had been lying in the field for about eighteen months produced as good a fibre with less trouble as fresh (dry brown) husks. The explanation, no doubt, is that exposure to the weather for such a long time served the purpose of retting and the fibre was not damaged.

Coffee.—Progress in this crop has not been as satisfactory as could be wished, but it is entirely due to bad management on the part of the owners. Coffee culture at low levels in New Guinea is being carried out on a fairly large scale, but so far its economic possibilities are not altogether clear, largely on account of the lack of management with sufficient knowledge of the crop, and because the labour has to be taught. Where this state of affairs has been remedied, the prospects are much brighter for this comparatively new crop, so far as New Guinea is concerned.

On one plantation soil conditions were unusually good, climatic conditions entirely favorable; but, owing to ignorance and neglect, everything was allowed to go back. A smaller plantation in the neighbourhood, but with poorer soil, is looking excellent, and is, at the time of writing, heavily in flower.

Arabian coffee, growing at Wau, 3,500 feet above sea level, is yielding record crops and bringing highest prices. This coffee was introduced by the Department from Jamaica nine years ago, and planted on the Department's little experimental station on the Wau, which has since passed into private hands. Some seed of this coffee has been planted at the new Agricultural Station, Aiyura, on the Upper Ramu, and is progressing well. Report states that the plants are thriving, and they should be in bearing four years from planting. The Lutheran missions are also growing Arabian coffee for their own requirements, and are encouraging the natives to plant it also, the crops being purchased by the mission. The samples of this native-grown product are very good indeed, and the enterprise of the mission in this matter is an instance of practical co-operation, which is greatly appreciated.

The export of coffee from the Territory amounted to 41 tons, valued at £1,025.

Cocoa.—Production of this crop is steadily increasing. The Department has supplied specially selected seed to planters from trees of second generation of high yielders, and advice has been given to planters by articles in the *New Guinea Agricultural Gazette*, correspondence, and inspection of plantations by various technical officers of the Department.

Owing to the lack of experienced cocoa planters after Australian occupation of the Territory, the export of this product had practically ceased. The trees had deteriorated from neglect, and on the Department's first attempt to resuscitate

the industry, it was found necessary, in 1928-29, to advise that the trees on one of the oldest and best properties be cut hard back to form new trunks. The cocoa beans also were, in many cases, of such inferior quality that manufacturers at last would not look at them, some going so far as to say that New Guinea could not grow cocoa. By the action of the Department in growing specially-selected plants as mother-trees for the supply of good quality beans, and giving instructions in curing, there has been a decided change recently in the attitude of Australian manufacturers to New Guinea cocoa.

The general standard of our cocoa has been so raised that many shipments have been classed as equal to the best Trinidad on the London market, which has had a beneficial reaction on the Australian market.

Cinchona.—There has been excellent growth of all the *Cinchona* plants on the Upper Ramu, but the exceptionally dry weather experienced there has been some check to their growth. This will be overcome, no doubt, when the wet season sets in.

Tea.—Three hundred and fifty tea plants now growing at Aiyura, 6,000 feet, have been planted as mother-trees to supply seed to future tea-planters, for, naturally, it would be impossible to establish any new agricultural industry unless planting material was available. Many planters do not realize that tea seed, like that of many other tropical plants, is of extremely brief viability, so that many previous attempts to introduce tea seed to the Territory proved futile. The tea plant is also a very slow grower, and some years must elapse before it will be bearing seed. Owing to the restrictions on the export of tea-planting material from most countries, it has been extremely difficult to obtain such material for this Territory. The successful introduction, therefore, of even a few hundred tea plants into the Territory is of national importance.

Derris.—Every effort has been made to encourage the cultivation of this crop. In addition to using the indigenous *Derris elliptica*, the Director, on two occasions, brought different types of the plant from Malaya; in 1932 from Province Wellesley, and, in 1935, Changi No. 3 from Singapore. *Derris* requires cultivation like an annual crop, not unlike that given to sweet potatoes, but once the ground is covered, practically no further cultivation is necessary. One planter has made further inquiries about the crop, but local planters generally appear uninterested.

Rubber.—There are 1,800 ha. of rubber planted in the Territory, the greater part of which is *Ficus indica* (Assam rubber), which is not adaptable for plantation production. The proportion under Para rubber (*Hevea brasiliensis*) is small and little interest is taken in rubber production. A former rubber planter from Papua has, however, recently leased an abandoned area of Para rubber, portion of a large estate, and has every prospect of being successful. The rubber trees have been absolutely neglected for so many years that the tall secondary bush has grown up between the lines to form veritable jungle. This is all being removed to allow light and air to get to the rubber, which is responding with remarkable rapidity to improved conditions. The Department has helped this planter with suitable leguminous cover plants to keep down the undergrowth, and has given him advice for which he has expressed his appreciation.

There are numerous other smaller areas of Para rubber that could be profitably tapped, and advice has been given to the owners concerned; but, up to date, the only planter who has profited by such advice is the one to which reference has already been made. There are several Para rubber trees in the Botanic Gardens, all of which have been test tapped for latex production, and all the small yielders have been removed. The few remaining trees, therefore, should be good mother-trees for seed, as there are no poor yielders left to cross pollinate with them.

Vegetables.—Seeds of some European vegetables, including cauliflowers from Indian-grown plants, have been cultivated experimentally in different parts of the Territory. The results from cauliflower have been fairly satisfactory, as quite good heads have been produced in Rabaul and at the Demonstration Plantation. The cauliflowers will not go to seed at low levels in this latitude, but experiments are being made to produce seed at Aiyura and mission stations in the highlands on the mainland of New Guinea, and, if successful, the plants may even enter into the dietary of natives, as has been the case with shallots, tomatoes and cabbage.

Peanuts.—The cultivation of this crop is carried on to a limited extent, but, apparently, it is considered too much of a minor industry to warrant the attention of the local European planters. Its cultivation, however, has entered into the economic life of the native population, as it is always now found in their gardens, and has become a regular article in their diet. It is also to be seen for sale in native markets.

Jungle Products.—There has been practically no advance made in the collection and export of jungle products. Small shipments of rattan have been sent to Australia, but manufacturers there are able to obtain regular shipments from the East Indies, and it is only natural that small lots at irregular intervals would have little chance of sale on an open market. The efforts of the Department in this direction have, so far, been without satisfactory results.

Pests and Diseases.

A serious outbreak of *Promecotheca* occurred near Rabaul towards the end of the year. It was first observed by officers of the Department of Agriculture at the end of November, when the infestation was only slight, and an Inspector was sent out early in December to investigate. Advice was given as to how to deal with the pest by the only practicable methods known, and which were used successfully in the much greater infestation in the Philippines in 1931, where millions of trees were affected. Insect pests on plants like palms 30 to 60 or more feet in height are naturally more difficult to deal with than any ordinary orchard crop.

The local parasite *Eurytoma* sp. eventually brought this infestation under control. Colonies of this parasite have been distributed to other infested districts, and will be of assistance to an appreciable extent in keeping the pest down until *Pleurotropis parvulus* has been introduced.

The Coco-nut Tree Hopper, Sexava spp.—This serious pest still gives considerable cause for concern, but every possible means within the power of the Department is being used to bring it under control.

A power-duster for use primarily against this pest was imported, and reports so far indicate that it will be satisfactory.

Although *Sexava* parasites have proved effective in certain districts in controlling the pest, some factor, yet unknown, retards their effectiveness in the Manus group. There is good reason to think that poor soil conditions reduce the vitality of the palms, thus rendering them less resistant to both insect and disease attack. This is in accord with the views of leading authorities in entomology and tropical agriculture, who state that unsuitable soil conditions and improper plantation maintenance are the main causes of damage by insect pests and diseases. To improve soil conditions on the plantation where the Field Laboratory is established in Manus, experiments are being made with green manures and tall cover plants, also with the object of providing shelter for the newly-emerged egg-parasites (minute wasps) from strong winds to which the station is exposed.

A new *Diseases of Plants Ordinance* has been brought into legislation, giving power to the Department to compel growers to take action in controlling their pests and diseases, in accordance with the technical advice given to them by the Department of Agriculture.

Assistance to Planters.

As in former years, every possible assistance has been given to planters by the Department. Small quantities of economic seeds have been given, gratis, for experimental purposes. When necessary, an Inspector and Instructor, the Director himself, or other technical officers have gone to plantations for an inspection, and to render advice which, unfortunately, is not always taken, and, in certain cases, with serious consequences, of which the outbreak of *Promecotheca* is an example.

Planting material from selected cocoa and other trees has been supplied from the Demonstration Plantation to growers, in large quantities, for their plantations, and, in this way alone, a great deal has been done, not only to increase the quantity but also the quality of such products. In cases where it is found that the copra from a certain plantation continues to be of inferior quality, a letter is sent to the planter advising him of the fact, explaining the probable cause, and, if there is little or no improvement, an Inspector is sent to the plantation to correct the fault, with beneficial results. The same is also done with the cocoa planter, and it is hoped that, when the proposed cocoa inspection scheme is brought into force, no inferior cocoa will be exported from this Territory.

Samples of soil, &c., have been sent to the Council for Scientific and Industrial Research at the Waite Institute in Australia for analysis on behalf of planters, but, on the appointment of an Agricultural Chemist, this will not be necessary, as all such work can be performed by the Department.

Avenues in Rabaul.

The avenues that suffered severely from the eruption have recovered remarkably well—the result of the careful pruning they received. This is very noticeable, as trees that were in out-of-the-way places and overlooked and not pruned, never recovered, and, in some cases, even died.

Native Agriculture.

In establishing native coco-nut groves the custom was to instruct each male native to plant so many palms per annum, and no record was kept as to location of areas of groves, or even the number of natives employed. Consequently, the Department found the proper maintenance of such groves by an occasional visit of an Inspector and Instructor to a district an almost hopeless task. Efforts were then made to remedy this, and each Inspector was instructed to obtain full details of every coco-nut grove in the district patrolled and show its approximate position in the map. The work has been checked and re-checked in subsequent patrols, and a careful account is kept in the Head Office. In this way, the Department has fairly accurate particulars of almost every native coco-nut grove in the Territory, especially in Bougainville, where an agricultural officer is permanently stationed, and when each administrative district is so served, the native coco-nut industry can be put on a satisfactory basis.

In the neighbourhood of Rabaul, where the natives are more enlightened and sophisticated than those of the bush, they have been instructed in improved methods of copra making. The copra Inspectors at Rabaul, or other officers of the Department, make an inspection of the driers, whenever it is considered necessary, to remedy any faults in the drying methods, and, because of this, some native copra is even superior to the average plantation products. Other native copra is, however, still very inferior, and is usually passed for shipment as "trade". Native copra from Rabaul district amounted to 887 tons.

In addition to placing the native coco-nut growers on a more satisfactory basis, the Department is doing much to improve the general agricultural practices amongst natives by instruction from the agricultural officers on patrol, and, when Inspectors and Instructors are permanently stationed to each district, this work can be carried out even more effectively. Natives are naturally very conservative, and it would be quite useless to try and make scientific farmers of them in a generation. The Department's chief problem, therefore, is to find some alternative to their "shifting cultivation", which requires large areas and the burning of the trees, which is responsible for soil deterioration in native lands throughout the Territory. This evil is accentuated by natives being encouraged to grow money crops by this unskillful method, particularly in the neighbourhood of the larger European settlements. The Department is endeavouring to overcome this by modifying the methods employed in their gardens by the use of cover plants, rotation crops, and green manuring. It is obvious, however, that something more than advice and demonstration is necessary to overcome the evil which is doing incalculable harm to the Territory.

New food plants are introduced to native gardens, and strains of some of their own food plants are being improved in quality and quantity by selection, several of which have already been distributed.

Several of the missionary societies have rendered assistance in this work.

New Britain.—Native agriculture suffered such a severe check from the eruption that a long time must elapse before gardening conditions will be normal.

In some areas, near to the new volcano, natives have had to dig trenches 5 feet deep through the pumice to the soil beneath for planting their bananas. Other land could be made available for them, but they are so wedded to their

own locality they they will not move. Efforts are being made to improve the raw pumice by incorporating green manures and other vegetable matter, so that sweet potatoes and similar food crops can be grown.

European vegetables are now coming into the native market in moderate quantities, and there is good reason to hope that this branch of native agriculture will soon be normal. In all other parts of New Britain the cultivation of native sustenance and money crops like coco-nuts is fully maintained.

New Ireland.—Native agriculture in this district is in a very healthy condition. In fact, in some cases, the natives have more coco-nut groves than they can maintain, and there is a sufficiency of food crops.

Kieta District.—The Inspector and Instructor stationed in this district has native agriculture organized on a very satisfactory basis, and all coco-nut groves are maintained in first-class order.

Manus.—This is one of the most unsatisfactory districts in the Territory for native agriculture—the soil being shallow—and natives depend largely upon sago (sak sak) and fish for their sustenance. An Inspector and Instructor has been stationed here, however, with the object of introducing shallow-rooting food crops.

Sepik.—An officer has been stationed in this district, and is putting native agriculture on a satisfactory footing. The soil in this district, on the mainland of New Guinea, is very suitable for agriculture, and native gardens there are large and well maintained.

ENTOMOLOGICAL.

During the absence of the Director on leave from 12th November, 1937, to 19th February, 1938, the Entomologist was appointed Acting Director.

Contact has been maintained with entomological workers overseas and with a number of firms in England and the United States of America in reference to dusting and spraying machinery and various insecticides. Samples of several insecticides have been forwarded for testing as a result of this correspondence, and the latest information has been obtained on suppliers and prices for the use of planters.

Through the courtesy of the Manager, Levers Pacific Plantations Ltd., we have been kept advised of the work being carried out by the Entomologists in the British Solomon Islands on the problem of "nut-fall" caused by the *Coreid* bug, *Amblypelta cocophaga*, China.

Pest-control Machinery.—A 6 horse-power machine for dusting was received from England in February, 1938.

Two different types of power-spraying machines are on order, both from England.

A mechanical, hand-operated, dust mixing machine is on order from the United States of America.

Insecticides.—Calcium arsenate and lead arsenate have been obtained in quantity from Australia for field trials against insect pests, especially *Sexava*.

From inquiries made overseas, it has been found that the prices of insecticides are much less than those operating in Australia. Supplies have been ordered accordingly, and comparative trials will be made to test the relative toxicity and other properties.

Pest Infestations.

Coco-nuts.—*Sexava* infestation that had been severe on portions of both the east and west coasts of New Ireland in 1936 had cleared up by the early part of the latter half of 1937. There had been a similar infestation in the Rabaul-Kokopo area of New Britain about the same period, but this had also cleared up by the time stated above.

In the Manus District some plantations reported a moderate to severe *Sexava* infestation about the same time. Outbreaks of this pest were also reported on some plantations in the Madang District during the later months of 1937.

In all the above districts, a little *Sexava* feeding is always in evidence.

Along the north coast from Rabaul, an outbreak of *Promecotheca antiqua* started at the end of November, 1937, and a severe infestation rapidly developed. Signs of parasite control were observable by the end of March, 1938, in one portion of the area affected, and in the other sections by early in May; the former is showing good recovery, but the latter sections will take much longer to develop full foliage.

Aspidiotus destructor was reported from the Western Islands to be causing damage to coco-nut palms, and a colony of predaceous *Coccinellidae* was forwarded from Manus to assist in controlling the pest.

Palm weevils, *Rhynchophorus* spp., caused a considerable amount of damage in certain areas in the Kokopo District, and necessitated the use of regular pest gangs and considerable supervision to maintain control.

Cocoa.—The weevil, *Pantorhytes plutus*, has continued to cause trouble in cocoa in parts of New Britain; one planter has reported a good measure of control by spraying the trees with arsenate of lead. Inquiries from other cocoa-producing countries have failed to elicit any records of this weevil, and no information was available on any possible parasites.

Rhyparida obscuripennis and other spp. of *Rhyparida* (*Eumolpidae*) have caused damage to young tip foliage when occurring in any numbers, resulting in tip malformation and stunting.

A *Lepidopterous* stem borer, *Zeuzera coffeae*, Nietn. (*Cossidae*) has been occasionally met with.

Larvae of *Cerambycidae* have occurred fairly frequently in branches of cocoa, and *Dictamia* sp. has been bred out from one lot of infested material.

Two species of *Thysanoptera* (*Heliothrips haemorrhoidalis*, Boisd., and *Selenothrips rubrocinctus*, Giard.) have been collected on cocoa foliage in both the Kokopo area and in the Kieta District; it has not so far been found to be a serious pest.

"Mealybug", *Pseudococcus* sp., has been collected on the base of the stem of cocoa plants growing in a slightly sandy soil, but has not been serious.

Coffee.—"Mealybugs", *Ferrisia virgata* and *Pseudococcus* spp., have caused considerable damage to coffee trees, and *Leucaena glauca* as shade, in both the Kieta and Bainings Districts. Variation in shade materially lessened the attack on the Bainings property.

The "hard scale", *Coccus viridis*, is general in occurrence, and its control has necessitated a considerable amount of spraying with oil sprays.

The same *Lepidopterous* stem borer, *Zeuzera coffeae*, Nietn., as occurs in cocoa is occasionally met with doing similar damage to coffee trees.

General.—Various pests have been reported on vegetables.

Ants in dwellings and on schooners have been subjects of inquiries during the year, and suggestions and demonstrations for control have been given.

The first flush of growth on trees and shrubs in Rabaul after the eruption continued to be very severely attacked by various *Lepidopterous* larvae, and this called for a considerable amount of attention. Larvae were collected and adults bred out for identification from a large number of host plants.

Achaea janata (*Noctuidae*), a serious pest of castor oil plants, was bred from hosts not previously recorded in the Territory.

Sexava Research.—This has been continued, and special attention paid to the use of insecticides against this pest, both arsenicals and derris and pyrethrum mixtures being tested; in laboratory cage trials, calcium and lead arsenates gave the best economic results, and field trials have therefore been confined to these two insecticides. Owing to the late arrival of the power-dusting machine, the field trials are not as far advanced as was hoped would have been the case, but it appears evident from the results to date that a very high percentage of the "hoppers" are killed by an application of either of these insecticides into the heads of the palms, and the costs appear to be strictly moderate, especially with calcium arsenate. Further work is planned to test other fillers than lime to ascertain comparative adhesive powers, as the foliage of coco-nuts is so exceedingly smooth as to offer but little mechanical adhesion of dusts.

The breeding of parasites for liberation is being maintained, and tests with "tanglefoot" banding have been continued.

Distribution of Sexava Egg Parasites.—Colonies of parasitized *Sexava* eggs have been distributed, both from Manus and from New Hanover, to various sites in the New Ireland District, and, also, to New Britain, where *Sexava* is known to be present. Distribution from New Hanover offers the possibility of transference of at least three species of parasitic *Microhymenoptera*, two of which have been found to be extremely difficult to breed in the laboratory in numbers sufficient for liberation under field conditions.

Promecotheca Research.—Studies of the life-history, habits and parasites of *Promecotheca antiqua* have been carried out in both the Manus and Rabaul Districts. The life-history of the larval parasite, *Eurytoma* sp., occurring on New Britain, was studied in Rabaul, and was bred in the laboratory in sufficient numbers to permit of distribution in localities in the infested area already referred to where the parasites were slow to make their appearance in appreciable numbers.

Egg and larval parasites of *P. antiqua* have been bred out in Manus by Mr. O'Connor, Assistant Entomologist, from material collected in the field. A detailed study of these parasites will be carried out as opportunity offers.

Pleurotropis parvulus.—This larval and pupal parasite of *Promecotheca ritchei* was imported from Java into the New Hebrides at the end of 1937, and arrangements were then made to obtain a colony for this Territory as soon as the parasite was established in its new habitat. The colony was duly forwarded by M. Dupertuis, but, owing to various unforeseen and unavoidable delays in

transit, the period during which they had to be kept in cold storage was so prolonged that the whole colony was killed. Plans for a further introduction of this useful insect are in hand.

Moth Infestation of Copra and Rice.—Considerable attention has been paid recently to this problem, which has been a serious matter for a considerable time past, but a Territory-wide campaign is required for its successful control. After a study of the pest, *Ephestia cautella*, in storage sheds on plantations and at main storage depots, and on inter-island vessels, it is evident that the initial trouble lies on the plantations, but the trouble may be considerably aggravated during long storage in main depot sheds. This moth also has been the cause of complaints regarding cocoa beans from this Territory.

Plant Quarantine Inspection.

Inspection of plants entering the Territory, particularly through the port of Rabaul, has been maintained, and any material carrying live insects was fumigated.

Insect Collections.

The insect collections have been maintained during the year, and a large number of specimens have been added from various parts of the Territory.

Over 600 specimens have been despatched to the Imperial Institute of Entomology, London, and 358 identified species have been received from that Institute. In addition, other specimens have been forwarded to specialists—*Coccidae*, Dr. Laing, British Museum of Natural History; *Cicindellidae*, Dr. W. Horn, Berlin; *Collembola*, Mr. Womersley, South Australian Museum; *Mallophaga*, Mr. G. B. Thompson, British Museum of Natural History—from all of whom identified species have been received.

Of the material sent to the Imperial Institute of Entomology, 40 species were retained for further study, 92 species were listed as "further specimens desired", and 12 species were not in the collections of that Institute.

Timber Pests.

In conjunction with the Forestry Officers, breeding of pests of timber has been carried out, and specimens of all insects bred out have been supplied to them for their collections.

Information on timber pests already known in this Territory has also been supplied to these officers.

ECONOMIC BOTANY.

Plant Breeding Investigations.

Owing to the broken time occasioned by travelling, this work was not advanced as far as could be desired; nevertheless, progress was made during the period under review.

Coco-nut cross-breeding and seed selection have now been well established at Keravat. This work was carefully discussed in the article on the subject published in *New Guinea Agricultural Gazette*, Vol. 4, No. 3, July, 1938, page 24, which also outlines future work. Since that time, however, successful artificial cross-pollination was carried out on a large scale between a dwarf variety, King Coco-nut, and the Markham strain of coco-nuts, which is also

a definite regional type. Thirty-three King Coco-nut palms were crossed with five Markham type of palms as pollen parents. A total of 1,095 flowers were pollinated, and an approximately 30 per cent. take was recorded on the first count; a small late fall is expected.

The final objective was the combination of a large nut, the size of the Markham type, with the early maturity of the dwarf coco-nut, so as to reduce the period at which coco-nuts come into profitable bearing.

Only the best palms in both types were selected, as all inferior palms were marked and cut down, so as to avoid their presence in the planted areas.

The difficulties of controlled cross-breeding of coco-nuts to produce early maturing palms are not so great as is generally believed, providing the various varieties to be used are in isolated blocks, as is the case at Keravat.

It was proved, in the course of this work, that some of the palms showed an hereditary tendency to produce nuts with poor germination. In fact, some palms, although appearing normal as regards size of nut and amount of kernel, were found to be hereditary non-germinators.

As palms producing nuts of low germination or a high percentage of weak sickly plants are most undesirable, the importance of the seed selection, plus nursery and seed selection carried on at Keravat, is indicated as a sure guide to plantation practice.

The Department of Agriculture has also carried on a great deal of coco-nut introduction, and representative collections from outside countries, as well as from various parts of New Guinea, are being grown in connexion with the breeding programme mentioned. Most interesting and valuable introductions have recently been obtained through the courtesy of the Director of Agriculture, Fiji. The six selections received are the result of coco-nut cross-breeding by Marechal, between the Fijian dwarf palms, named Niu luka, and the Malayan dwarf palms.

It is claimed that these resultant selections may commence to bear coco-nuts before the spathes rise above the ground. Improved selected strains of coco-nuts from Menado Coco-nut Experimental Station, Celebes, N.E.I., were also introduced. A supply of "Macupuna" nuts was introduced from the Bureau of Plant Industry, Manila, as being especially valuable for native food requirements.

Original investigations on the floral biology of coco-nuts were also commenced both at Keravat and on outside plantations, such as Meto, Witu Group.

Coffee Cross-Breeding.—The following crosses were successfully made between Java strains and Keravat selections of coffee:—

K.B4 x Bangelan 105-01-K4.

K.B6 x Soembar Asim Selection No. 78.

Also between Bangelan 105-01 (K4) and Bangelan 105-01 (K21), both selections from the Bangelan strain, which is doing well at Keravat.

It has been found that two coffee selections made from bulk plantings have compared more than favorably with Java strains, sown under the same conditions and at the same time.

In the coffee selection block, seedless strains of the shade tree *Leucaena glauca*, comparable with the "lanang" strains of this tree from Java, were found, and later isolated. As the production of too many seed pods is the disadvantage of this tree, these seedless types are valuable.

Cacao Improvement.—Cacao is more liable to self-pollination than crops such as coffee and coco-nuts, which are more liable to cross-pollination. Generative or seed selection thus has a sounder basis and greater hope of success with cacao than is the case with the other crops mentioned. The diversity of types present shows that some out-crossing does occur, thus vegetative methods are necessary before any complete uniformity is obtained.

Several of the best cacao trees at Keravat were selected for yield and uniformity of quality, and were increased into clones or vegetative populations, as far as possible, by budding and approach grafting, both "fan" and "chupon" scions being employed for comparison. In most cases, the selected "mother" trees were grafted back on their own seedling stocks, so as to increase the material available for distribution and further testing on a larger scale.

Rubber Test Tapping.—Test tapping of rubber, *Hevea Brasiliensis*, was again carried out in the Botanic Gardens, Rabaul, and, after the results were available, all inferior trees were cut out altogether to allow of cross-pollination between superior yielding types only. Seeds of the trees which are left are intended for planting in test areas.

The eruption interrupted the continuance of the second series of tests, but these were later recommenced when the trees had recovered sufficiently, with the object of isolating heavy yielding strains.

It was found that the trees which yielded best in the first test also did so in the second test, despite the altered environmental conditions. In this manner, ten high yielding "mother" trees were isolated, of which Rabaul No. 608 was easily the best in the both tests, and yielded more than three times as much as the mean yield for all the trees included.

Large rubber nurseries were established, but owing to the eruption spoiling the young trees, very little progress was made with bud-grafting as intended. It is an important finding that high yielding strains of *Hevea* are present in this Territory.

Tests instituted by a private planter on an old established rubber area in New Guinea, show that our natives can be taught to tap rubber satisfactorily.

PLANT DISEASE INVESTIGATIONS.

Manurial Deficiencies in Coco-nut Palms.—This work was commenced, although there was at the time no chemist present, as it was considered urgent that some aspects of the deficiency problem in coco-nuts and coffee soils be dealt with, despite the fact that this was not strictly within the province of the Economic Botanist.

Chlorosis, deficiency diseases and general debility in the coco-nut palms in some plantations, which are due to soil exhaustion and are also inter-related with the age of the palms, are the greatest problems to be faced in New Guinea plantations.

Preliminary tests have served to indicate that there is a very big and important field of research available on these problems.

Coco-nuts suffering from *chlorosis* in the Bainings District, and more particularly on the north coast of the Gazelle Peninsula recovered their green colour remarkably well after the recent volcanic deposition had taken effect.

Analyses have shown that the pumice and ash were rich in soluble potash and gypsum (CaSO_4), but very low in phosphoric acid and nitrogen. It must be remembered, however, that there were rare metals and substances, such as magnesium, contained in this ash, which undoubtedly had some effect as did the temporary choking of kunai, *Imperata arundinacea*, and other weed growths. There is some rather definite proof that either unbalanced nitrogen and potash content or actual potash deficiency are involved as important aspects of coco-nut *chlorosis* in the Gazelle Peninsula.

Owing to the lack of data and because of conflicting results with single fertilizers, a test was conducted with a complete fertilizer consisting of a mixture of sulphate of ammonia, sulphate of potash and superphosphate, the rate of application being 8 lb. per individual palm, unmanured plots being included for comparison.

Although it was too early for the effect to be seen on the palms, the effect of the manure on the ground flora was most noticeable.

It was indicated that on the manured trees, the kunai tended to be choked out by a dense growth of softer grasses, sedges and legumes, showing that kunai becomes only dominant on nitrogen deficient soils in the presence of excess sunlight.

This effect only appeared where the manure was applied, and it further emphasized that cultivation, cover cropping and manuring are closely inter-related problems, and that they could well follow in rotation, and in the order mentioned.

Direct methods of injecting ten different chemicals into the coco-nuts through auger holes made in the trunks of coco-nut palms, were tried, using strengths of solutions ranging from 1/200th to 1/1600th. Cobalt chloride, borax, zinc sulphate, copper sulphate, magnesium sulphate, ferrous sulphate, solid iron citrate, sulphate of potash and sulphate of ammonia, were the chemicals used, and some of these gave immediate and beneficial effects. Iron sulphate has also been tried out on plantations as a manure, and has given good results.

From what can be seen from preliminary tests, there is practically a general deficiency of manurial ingredients in the soil here, while the nitrogen status and water holding capacity is not good. Much more field experimentation combined with pot culture experiments, and soil and leaf analyses, which are the province of a chemist, are required.

Thus experiments with erect cover crops such as *Crotalaria*, *Tephrosia* and *Leucaena glauca* are being initiated as is the investigation of rare metal deficiencies.

By applying better cultural methods, eliminating kunai and establishing leguminous cover plants, several plantations have been greatly improved recently, though they were formerly believed to be almost irrecoverable.

Tests with applications of solid compounds of all the substances mentioned, to be applied direct to the palms, are under way.

Coffee Diseases.—In the larger New Guinea coffee plantations, it was noticed that the presence of *chlorosis* or yellowing in the coffee bushes was extremely prevalent in certain areas. It was also noticed that several kinds of plants, growing in close proximity to the coffee areas, showed a related *chlorosis*, showing that the deficiency was general. Citrus trees growing near the coffee showed a distinct mottled *chlorosis*, combined with shortening and deformation of the leaves. It was also observed in patches of *Desmodium scorpiurus*, bananas, native grasses, *Crotalaria* and on a native bush tree *Leea* spp.

Chemical analysis of the soil on this particular plantation, seemed to indicate that a general deficiency was involved, although the percentage of potash (K_2O), soluble in 1 per cent. citric acid, was high.

It appeared, however, that there was a marked lack of balance between the amount of nitrogen and potassium present, and that the ratio was too wide. Cover cropping and the use of waste coffee pulp and compost was recommended. After every effort was made to keep up the humus status of the soils by planting *Crotalaria* and cover crops, the coffee areas improved greatly.

Root Rots.—Diseases of this nature caused mainly by the fungus *Fomes lamoensis*, which causes brown root-rot, were prevalent in coffee plantations last season. Several other fungi, however, were involved in other specimens received from Bougainville and Wau. Specimens have been sent to Professor Ashby, Director of the Imperial Mycological Institute for identification of the fungi concerned.

In one case, over 2,000 Arabian coffee plants growing at low levels became badly diseased, and had to be cut out. Root-rotting fungi were present, but it is believed that they were secondary in their effect to that of soil conditions, density of shade and other environmental factors, as another area in the same plantation, remained quite healthy. This was also confirmed by the fact that a species of *Diplodia*, which is usually associated with "Dieback" was found on twigs of this coffee. *Polyporus zonalis* or other species, was the fungus mainly associated with cacao root-rotting at Keravat.

Coco-nut Diseases.—Professor Ashby considered that the physiological disease present in coco-nuts just coming into bearing may be identical with the "Cadang Cadang" disease described by Ocfemia in the Philippines, and believed to be a virus disease. In August, 1937, this physiological set-back was again seen at Namatanai in palms reaching the bearing stage, but, as the palms soon recovered, it is believed that the condition is almost certainly physiological, due to the extra demand for water and nutrients at this critical stage, not being met under certain dry weather conditions on a heavy soil.

It was recorded that a "gummy leaf" condition of coco-nuts, where the fronds failed to expand properly, was common on the Witu Islands, where strangely enough, the "Head Droop" common on New Ireland and other places, was not seen. As these palms seldom bear nuts, it is recommended to destroy them.

Areas where falls of mature coco-nut palms occurred were investigated at Witu and Bougainville, and a gazette article for publication was prepared on this subject. In one area restriction of the root-system, due to a hardened layer present in the sub-soil zone, caused the palms to fall over in strong winds, after they had reached a certain height.

Plant Introduction and Plant Exchange.—This work has been carried on with other countries on a fairly large scale. The state of the nurseries due to the eruption, as well as the loss of young plants occasioned by it, curtailed the work in the Botanic Gardens to some extent last season, but the introduction of desirable new economic crops for Keravat proceeded as before.

In addition to other crops, new varieties of tobacco, citrus, avocados, mangoes, kapoolasan nuts, cloves and vegetables were brought in, together with numerous ornamental plants.

Coco-nut Literature.—As the Department of Agriculture is particularly interested in coco-nuts, steps were taken to compile a complete bibliography and index on all aspects of coco-nut culture, but especially as regards diseases, seed selection and plant breeding.

Investigations by the Department of Agriculture on forest products, have been largely discontinued as this work now comes within the scope of the newly formed Forestry Section of the Lands Department. It is as well to indicate, however, that one species of a thin binding rattan, collected from the Sepik River, has distinct commercial value if it is present in sufficient quantity. Investigation has also been conducted on the candlenut, *Aleurites Moluccana*, but, although the candlenut oil, at a favorable price, should find a definite use in the paint and varnish industry, its commercial exploitation is not promising, where the Australian crushing firms require the nuts to be opened and the kernels extracted here.

Poisonous Plants Seen in New Guinea.—The following list of plants should be of interest as being known to have poisonous properties:—

<i>Barringtonia speciosa</i>	
<i>Derris elliptica</i>	{ One of these responsible for the death of natives last year.
<i>Derris uliginosa</i>	
<i>Excoecaria agallocha</i>	{ Known to natives and recognized by them as a deadly poison.
<i>Excoecaria acuminata</i>	
<i>Asclepia curassavica</i>	{ Cottony milk weed or red top. Many times recorded as having killed cattle here under certain circumstances.
<i>Jatropha Curcas</i>	
	Seeds are especially dangerous.

HERBARIUM.

Most of the doubtful identifications in the Botanic Gardens were checked by collecting dried specimens and sending them to Kew and to the Government Botanist, Queensland, for identifications. Such named trees and plants were then adequately labelled.

An extensive Herbarium collection made by Kajewski in Bougainville Island and presented to the Department a few years ago, was properly mounted and carded. The identifications of this collection were recently supplied as far as possible, through the courtesy of Dr. E. D. Merrill, Director of the Arnold Arboretum, United States of America.

Specimens of timber trees present here, and collected by the Forestry Officers were retained in the Herbarium and identifications are gradually being received. It is hoped to grow any newly identified trees in the Botanic Gardens as a living arboretum as far as can be arranged.

BOTANIC GARDENS.

The main work of the year has been associated with the rehabilitation of the gardens after the severe damage caused by the eruption, and the subsequent floodings. The gardens have made a remarkable recovery, although they do not appear so attractive as formerly, owing to broken-off branches of trees not being replaced, and because the lawns have not fully recovered. The not inconsiderable percentage of salt (NaCl) present in the dust plus the tendency of the soft palpable dust to set has done considerable damage to small soft and newly-introduced plants, but this effect is gradually disappearing.

Ferrieres and rockeries have all been replaced and repotting carried out several times.

Manuring with compost is being carried out continuously and thoroughly with material prepared from town rubbish and night-soil, treated by the Indore process, which work has been greatly facilitated by the assignment of a motor lorry to the gardens.

The work of re-conditioning the Botanic Gardens has been handicapped by the lack of an adequate water supply during a spell of dry weather amounting to almost drought conditions. Attempts were made to plant grasses in the lawns, but this has met with only moderate success on account of the factors indicated. The nurseries were severely set back by continued floodings, carrying pumice, and because of the unsuitability of the new volcanic deposits for plant growth. This is being overcome gradually. The large, new, and rather unsightly drain running through the gardens to carry off excess flood water was bridged, at intervals, with artistic cement bridges, by the Chinese carpenter. Hedges of casuarinas and bamboos were grown to hide the bare and raised banks, which are being gradually levelled and covered.

The main paths skirting this drain, and those running through the gardens, have been widened and levelled; they now require metalling or gravelling.

All of the plants present in the gardens were listed according to botanic classification, and in alphabetical order, and set out on suitable plans and sheets. The plants were all labelled with aluminium labels on which the lettering and numbering was carried out with a new embossing machine, which has proved very handy. These labels are for necessary permanent marking and nursery work, but do not display the lettering like enamel or porcelain labels.

Numerous gardens and hedges in the town of Rabaul, which had been destroyed, were replanted or else planting material supplied for them.

A new Chinese cemetery has been laid out to meet future needs.

ECONOMIC SECTION.

The nurseries, although full of young plants of coffee, citrus and rubber at the time of the eruption, were covered with so much eruption deposit that they have been unsuited for this purpose since. Decided attempts have been made to alleviate the soil in the main areas by growing erect, green manure crops, such as *Leucaena glauca*, *Tephrosia candida*, *Crotalaria* spp. and cow peas, which are cut down and dug in at intervals. It is believed that this area will not be available for cropping until it is composted all over and artificially manured, which work will necessarily take some time.

DEMONSTRATION PLANTATION—KERA VAT.

During the year under review, the cultivated area of the plantation was increased by 120 acres and 94 acres were felled in preparation for clearing next year. The total area at present under cultivation, and in the course of clearing for cultivation, amounts to approximately 500 acres.

As development progressed, the newly cleared areas, and areas of fallen bush, were linked by roads to the older established sections of the estate. Approximately 274 chains of new roads were constructed, and, at the close of the year, the roads available for vehicular traffic totalled 6½ miles.

A large creek, which is 70 feet from bank to bank and 20 feet deep, was bridged to provide road communication between the new area and the existing cultivation.

Further long-term experiments were laid down in respect to coffee, cacao and coco-nuts. A yield trial of taro and a cultivation trial of mammee-yams were completed, and individual plant selection experiments commenced with these two important native food crops.

Meteorology.—The rainfall during the year was 87.13 inches, which is 21.59 inches lower than last year. The heaviest falls occurred in August, 10.26 inches; September, 10.87 inches; and January, 9.73 inches.

Plantation Activities.—

PERMANENT CROPS.

Cacao.—Maintenance work in connexion with this crop was carried out during the year, and yield records kept of all selected trees.

The young area of bulk selected cacao which was planted in September, 1935, commenced bearing. It is pleasing to note that an examination of the trees as they come into bearing shows that they are producing beans of the desired colour, shape and size. Therefore, this section should provide excellent material for furthering selection work. Although in this area, shade density has some effect on the height of ramification, it would appear, at least with hybrid cacao, that this factor of ramification is in all probability somewhat generic, as in the four rows that were devoid of shade from the beginning, the height varied from 1 foot to 6 feet.

Ten Keravat selections and one Djati-Roennggo Hybrid ex. Java were planted in another section. The experimental lay-out of this block provides for a yield trial and observation of the eleven selections. At the close of the year, very good growth of the seedlings had taken place; a number have commenced to ramify and it is again evident that factors other than shade have some bearing on the height of ramification.

A spacing experiment was set out at distances of 12, 13, 14 and 15 feet on the equilateral triangle system. The 12, 13, 14 feet sections were planted and the seedlings are growing well.

A further block was planted with cacao and the area was divided into four equal sections, each containing 2.5 acres, and each section was planted with a single permanent shade tree variety, and two varieties of temporary shade. Five rows of each of the eleven cacao selections were planted in each section, in such a manner that when the block is taken as a whole, the selections are randomized throughout. During the coming wet season two varieties of creeping leguminous cover crops will be established. The experiment is designed to observe and compare the temporary and permanent shades, ground covers, and cacao selections; also for yield trials of the cacao selections and, later, pruning and manurial experiments can be conducted.

Another block was cleared and prepared as follows for cacao experimentation. It was divided into three sections—

No. 1 section lined 14 feet by 14 feet,

No. 2 section of 15 feet by 15 feet,

No. 3 section of 16 feet by 16 feet,

on the "quincunx" pattern. Each section was further divided into four equal parts, namely, A, B, C, D. The A and C portions were planted with Kong-kong

taro; the B and D portions with Kaffir Corn, as native food catch crops. When the catch crops have been harvested, *Tephrosia candida* or *Leucaena glauca* is to be planted as temporary shade, and, in the next wet season, each of the sections A, B, C, D will be divided, and half planted with selected seedling cacao, and half at "stake" with selected seed.

A laboratory experiment was conducted to observe the germination and growth of the cacao bean in respect to the position of the hilum in the soil, and the depth of planting. The experiment was fully described and published in the *New Guinea Agricultural Gazette*, Vol. 3, No. 2, December, 1937.

Cacao Budding.—In December, 1935, seedlings were taken from selected mother trees, and planted out in a separate block; the rows were 15 feet apart and thirteen seedlings were placed 15 feet apart in each row. In February, 1936, six seedlings from a selected stock number were also planted in the same rows.

When the seedlings had made sufficient growth, they were to be budded with "fan" and "chupon" buds from the mother trees, and, during the current year, this work was commenced. Unfortunately, it had to be discontinued as unfavorable weather conditions occurred, but it is hoped that the work can be carried out in the coming year.

Cacao Selection.—Cacao selection was carried a step further during the year, and a number of first filial generation selections was made.

In the month of September, a number of mother tree selections were made at Asalingi Plantation, in the Baining District, and the manager kindly consented to record the yields. It is interesting to note that in a letter received from the manager towards the close of the year, he stated that all the selections were producing well, a number would exceed the yield standard originally laid down, and that one tree had produced over 40 lb. of dry cacao in nine months.

Approach Grafting.—Fifteen "approach" grafts of seedlings to mother trees were made in each of the cacao selections and towards the end of the year, nine grafted seedlings from each tree were planted out. It is hoped that by this method of "approach" grafting the main characteristics of the mother tree will be reproduced, and that a quick method of establishing the original mother trees will be evolved in order to provide an additional number for the supply of planting material.

Coffee Selection.—The coffee selections introduced from Java and Malaya in 1935 commenced bearing during the year and a number of selections was made. When these introduced selections were planted a number of Keravat selected numbers were also planted in parallel rows with them for comparison purposes. Observations to date, indicate that in growth and early bearing, the Keravat selections compare very favorably with the best of the introductions.

Coffee Manuring.—Towards the middle of the year, an area of young coffee was manured in order to further observe the effect of single fertilizers on *chlorosis*. Sulphate of ammonia, nitrate of soda, superphosphate, sulphate of potash, and blood and bone were used, and applied at the rate of four ounces per tree. The observations made confirmed those in last year's trial on mature coffee, namely, that shade density appears to be the limiting factor. Where the shade was inadequate the number of chlorotic trees increased despite the applications of fertilizer, and where the shade was good a reduction in *chlorosis* occurred.

Selection Trial.—The trees in the selection trial which were planted in November, 1936, commenced flowering during the year. It is interesting to note that the Jackson's Hybrid selections are growing better than a large number of *Robusta* selections.

Spacing and Selection Trial.—An area was prepared towards the close of the year for a spacing and selection trial. It was divided into four sections, namely, A, B, C, D. Section A was lined and holed at 10 feet on the "Square" system, section B lined at 10 feet on the "equilateral" triangle system, section C at 8 feet on the "square"; and section D at 8 feet on the "equilateral" triangle. In the next wet season, these sections are to be planted with selections made from the introduced Java and Malayan strains, and the Keravat first filial generation selections.

Coco-nuts.—The area under coco-nuts was increased during the year by the addition of seedlings from Numa-Numa Estate, Bougainville Island.

Manurial Observations.—Manurial observations during the preceding year showed that the young coco-nuts improved when single fertilizers were applied, and, in the present year, a mixed fertilizer made up of 2 parts of superphosphate, 1 part sulphate of ammonia, 1 part sulphate of potash, was applied at the ratio of eight ounces per palm.

The beneficial effect of the mixture was very noticeable towards the close of the year, and a further application is to be made at the beginning of the coming wet season.

Spacing Experiment.—One coco-nut area was divided into three sections and lined, holed and planted at distances of 25 feet, 27 feet 6 inches, and 30 feet on the "equilateral triangle" system.

Cross Breeding.—A series of cross-breeding experiments were commenced during the month of March. King Coco-nuts (dwarf) were crossed with selected large nutted, heavy bearing, Markham Valley Coco-nuts (tall). A total of 1,095 flowers on thirty-three King palms were pollinated by five Markham Valley palms.

The first count of "set" female flowers took place in June and approximately thirty per cent. had taken.

It is worth recording that one Markham Valley palm that was used was planted in September, 1934, and at the age of 3½ years when the pollen was taken, it had ripened five coco-nuts and was carrying a crop of seventy.

Oil Palm.—The Oil Palm section was maintained and pruned during the year, and oil samples were prepared for the Australian Exposition of 1938.

Rubber.—In January, 1937, seed from a number of selected *Hevea brasiliensis* seedlings was received from the highest yielding trees in the Rabaul Botanic Gardens, and planted on the estate.

Fruit and Nuts.—The Philippine Islands Breadfruit are growing exceptionally well, and produced their first small crop.

Rambutan and Avocado Pear again bore crops, and a "free stone" Rambutan variety introduced from Java in 1934 produced its first crop; the fruit is large and juicy.

A variety of *Achras sapota* (Sapodilla) introduced from Java in 1934 produced its first small crop, and the fruit is large and excellent in flavour.

MARKET GARDEN SECTION.

During the year, a market garden section was commenced, the object being to test various varieties of vegetables and fruit, with a view towards ascertaining the best types and varieties for cultivation at low elevations.

Lima Bean.—In the month of July, three varieties of *Phaseolus lunatus*, and three varieties of *Phaseolus multiflorus* were introduced from Australia. Five of the six varieties failed, but a strain of *P. lunatus*, known as U.S. No. 2, produced a small amount of seed which after harvest was planted in multiplication rows. This variety is now growing and producing very well, the beans have exceptionally good table qualities and a number of seed distributions was made during the year.

Cauliflower.—A number of tropical cauliflower varieties was introduced at the commencement of the year. The plants grew very well, but the maturing period coincided with the wet season and the crop failed. Further seed was obtained, and, as it arrived at the close of the wet season, the plants at the present time are showing every indication of maturing before the wet season and producing well-formed heads.

Rock Melon.—Two varieties of rock melon, namely, "Rocky Ford" and "Hales Best", were planted at the beginning of the dry season and a good crop matured. Healthy plants producing good fruit were selected from this crop and plants raised from the selected seed are now growing well, are healthy, and it is apparent that another good crop will mature before the wet season. As it will be possible to grow two crops during the dry season of the year, Rock Melons during this season have definite potentialities as an adjunct to the usual tropical fruits for table use.

Lettuce.—Three varieties of lettuce, namely, "Tom Thumb", "All the Year Round", and "Green Mignonette", were successfully grown throughout the year.

Cabbage.—Success was obtained from the "Early Drumhead" variety of cabbage, but "Early St. John's Day" and "Aphis Proof" were failures. Other varieties are at present under trial.

Fibres.—Demonstration areas of the principal fibres, Manila hemp, Amani Sisal Hemp, Sauseviera Hemp, Sisal Hemp, Pineapple Fibre, Banana Hemp, Kapok, Jute, Cotton, Red and White Rozelle Fibre, were maintained during the year.

Spices.—A small demonstration area of pepper, vanilla, turmeric, ginger and cinnamon was maintained during the year.

Annual Oils.—Groundnuts were in continual cultivation, the varieties Red Spanish, Pearl and Rhodesian being mostly used. Groundnut issues were made from time to time to the native labour, and local orders for seed and food purposes were maintained.

A small area of two varieties of *Sesamum indicum* was kept in cultivation.

Drugs and Medicinal Plants.—Small demonstration areas of tobacco, *Tephrosia vogelii*, *Hydnocarpus anthelmintica*, and castor oil were maintained.

Insecticides.—A number of *Derris elliptica* selections was in constant cultivation, and a strain of *Derris Philippinensis* was introduced.

Cover Crops.—The area under leguminous cover crops was increased during the year, *Pueraria javanica* being the most extensive cover planted.

The following species were in cultivation throughout the year, and seed or cuttings were available for distribution:—

Psophocarpus palustris, *Pueraria javanica*, *Mimosa invisa*, *Centrosema pubescens*, *Calopogonium mucunoides*, *Dolichos hosei*, *Desmodium scorpiurus*, *Desmodium triflorum*, *Aeschynomene americana*.

Small blocks placed side by side were established with the main covers for demonstration purposes.

Green manure crops of *Crotalaria anagyroides*, *Tephrosia candida*, *Cajanus indicus*, Cowpea, Groundnuts were kept in continuous cultivation, and sufficient areas maintained to supply outside seed orders.

Small demonstration areas of the minor green manure crops such as *Canavalia* spp., *Phaseolus mungo*, *Tephrosia hookeriana*, *Tephrosia vogelii*, *Crotalaria walkeri*, *Clitoria cajanifolia*, *Crotalaria muijussa*, were maintained.

Shade Trees—Windbreak Trees.

The chief temporary and permanent shade tree and shrub varieties used in coffee and cacao cultivation are:—*Crotalaria anagyroides*, *Tephrosia candida*, *Leucaena glauca*, *Erythrina lithosperma*, *Erythrina glauca*, *Erythrina micropteryx*, and *Albizzia sumatrana*.

Other permanent shade and windbreak trees in cultivation are:—*Albizzia falcata*, *Adenanthers pavonica*, *Gliricidia maculata*, *Peltophorum inerme*, *Pithecolobium saman*, *Acacia* spp., *Cassia siamea*, *Cassia multijuga*, *Cassia fistula*, *Cassia grandis*, *Swietenia mahogani*, *Hydnocarpus anthelmintica*, *Bixa orellana*.

Giant Toads (*Bufo marinus*).

In the latter half of the year 1936-37, a number of Giant Toads (*Bufo marinus*) was introduced from Australia with the object of controlling insect pests on the estate. The toads have multiplied rapidly and large numbers are now on the plantation, some have even found their way to nearby estates.

It is interesting to note that for a number of years the *Desmodium triflorum* lawn at the Superintendent's bungalow was severely attacked three or four times a year by cutworms. During the current year, no attack has occurred and this is attributed to the presence of large numbers of *Bufo marinus* which appear to have taken up permanent residence in the garden.

AIYURA HIGH ALTITUDE STATION (5,825 Ft.).

General.—At the commencement of this year, the Station was still in its initial stage; as the year closes it presents a secure and settled appearance, with sufficient and effective station buildings, roads and a local aerodrome together with extensive areas under cultivation.

Buildings.—An Officer's Bungalow has been constructed of native materials with window frames and doors of local sawn timbers. Native labour accommodation for 60 labourers has been established, together with a station store and sheds for the storage of locally sawn timbers. All buildings have been constructed of native materials, but with care these should stand for a number of years.

Roads.—During the year, 1½ miles of station roads have been built; being 12 feet wide and well-drained, these have been constructed with a view towards future development.

'Drome.—In order to save labour and prevent unnecessary loss of time in transporting supplies from Ramu Post, it was decided early in the year to establish a local aerodrome. In all, 64 aircraft have landed during the year. The 'drome itself has been improved until now it provides two runways—one of 750 yards by 75 yards wide, running in a N.W.—S.E. direction, and the other of 400 yards by 75 yards running in an E.—W. direction.

In addition, a 'drome store has been constructed which enables air companies to store their supplies in safety. A wind sock that gives a good indication of the direction and velocity of the wind has been installed.

Cultivation.—Approximately 15 hectares have been placed under cultivation for permanent crops, annual crops, orchard, house garden, &c.

Meteorology.—The rainfall for the year was 78.44 inches, distributed fairly evenly throughout the year. The wettest months were October (10.15 in.) and February (9.65 in.), with the lowest fall in June, 1938 (2.31 in.). The highest daily gauging was 2.28 inches, but such a fall is very unusual. Most rains have been light and steady and have occurred generally at night.

The minimum air temperature recorded was 51.1 degrees F.

Permanent Crops.

Cinchona.—Six blocks each of ½ acre have been cleared in heavy bush country to accommodate the *Cinchona* series under trial.

These are:—

<i>Amani.</i>	<i>Bengal.</i>
1. <i>Robusta.</i>	1. <i>Ledgeriana.</i>
2. <i>Succirubra.</i>	2. <i>Succirubra.</i>
3. <i>Ledgeriana.</i>	3. <i>Ledg./Succ.</i>

The first seedlings from the Ramu nurseries were planted at Aiyura early in 1938 and at the close of the year 2,047 seedlings had been established and transplanted. This work could have been completed if dry conditions in May and June had not caused further planting to cease. Only favorable conditions are needed, and, when these occur, it is anticipated that approximately 4,000 seedlings will be established.

Compared with Java, the losses in the seedlings planted out at Aiyura are not high. Local losses in all varieties amount to 15 per cent. The remainder of the seedlings have struck and are thriving well, now being about 4 feet high.

It now appears certain that, even after a generous allowance is made for further losses in the seedlings still at Ramu nurseries, approximately 4,000 seedlings of three varieties (*Ledgeriana*, *Succirubra* and *Robusta*) and one hybrid (*Ledg./Succ.*) will be established in the field at Aiyura. Although this number is comparatively small, it should serve adequately for seed purposes and for the further establishment in more substantial quantities of all these varieties and afford opportunities for cross-breeding.

In removing seedlings from the nursery, the same technique as applied in Java was employed. That is, all vigorous plants over 3 ft. in height were pruned back and stripped of all leaves. But the roots have not been pruned. Local experience has shown that the Java pruning methods cannot be wisely applied to all varieties. Particularly, in regard to var. *Ledgeriana*, results have been better if the "leader" has been left intact and only the leaves removed. To remove the leaders of small seedlings up to 30 inches in height of any variety has been proved fatal.

In regard to shade, it has been found that var. *Ledgeriana* thrives best under adequate shade, whereas var. *Succirubra* resents it and thrives best under scant shade. The same applies to var. *Robusta*, which under local conditions at least, already has proved itself the hardiest of varieties.

The actual planting of all varieties has been on the 4'/4' basis. Holes have been dug 18 in. by 2 ft. deep and at planting have been filled with rich soil and leaf mould. The shade materials employed have been *Crotalaria anagyroides* and *Tephrosia Candida*, and where these have not been sufficiently advanced to be effective, artificial shade has been established. *Calapogonium mucunoides* has been established as a cover crop throughout the blocks.

Coffee Arabica.—*Blue Mountain*.—The 2-acre block necessary to receive seedlings raised from beans received from Wau has been prepared, lined and planted with shade material and the actual planting of these seedlings, now long overdue, will be made as soon as sufficient rain falls in the new year. All seedlings remain in a healthy state in the nursery at Aiyura.

Coffee Arabica.—In March of this year, five varieties of Coffee Arabica beans were received from Kenya. Successful germination was obtained and now approximately 400 seedlings are established of these varieties:—

- C. Arabica var. Harari.
- C. Arabica var. Columnasia.
- C. Arabica var. Maragogippe.
- C. Arabica var. Kenya (Drought Resistant).
- C. Arabica var. San Ramon.

Cyanide fumigation of this seed was conducted prior to planting.

Tea, British North Borneo.—These seedlings, numbering 179, were transported to Aiyura from Ramu in April last and have been established at this station. Favorable conditions are awaited before these will be planted in the block that has been prepared.

Fruits.—*Passiflora edulis* (*Passion Fruit*).—A small block of a quarter of an acre has been planted, the seedlings being planted 10'/10'. The vines have been trellised and are now bearing their first crop. The results are very encouraging. A plentiful supply of seedlings is now available for general distribution.

Ficus Carica (*Fig*). *Photinia japonica* (*Loquat*). *Citrus decumana*.—A few seedlings of each have been established in the orchard.

Physalis Peruviana—*Cape Gooseberry*.—Locally these grow in profusion and produce fruit of excellent size and quality.

Citrus Limonum—*Lemon*.—Approximately 500 seedlings have been raised locally, and are approaching the stage when they can be grafted or planted in the field.

Castor Oil.—In addition to the local variety established at Ramu last year, three new varieties were placed under trial, viz., Bombay Castor seed, Java Castor seed and Java Castor seed (Brown). In addition, Castor seed received from New Caledonia and India has produced a few seedlings. Adequate seed material is now available for what appears to be a remunerative crop.

Tung Oil.—*Aleurites fordii*.—Sixteen seedlings have been established in the field, and although these appear to be thriving, it is too early to forecast whether they will be entirely successful.

Root Crops.

With labour and attention required for other more important crops, sweet potatoes were the only root crop established. Approximately 3 hectares were planted under this crop, and for the last three months, the station labour has drawn on this supply for food. As local native foods can be purchased from natives at prices not exceeding 15s. per ton, it was considered unwise to concentrate on this crop when other work required more immediate attention. However, an additional 4 hectares of grassland have been cultivated, and will be placed under sweet potatoes after the permanent crops have been planted.

Annual Food Crops.

Maize.—Two varieties—Leamings and Golden Nuggett—were planted, each in half-acre blocks. These blocks have been harvested, satisfactory yields having been obtained. Ample seed material is now available for further, more extensive planting. A small quantity (10 lb.) of Red Nib variety has been received, and this will later be given a thorough trial.

Rodents have been particularly active in their attacks on this crop. Further reference is made to this under a separate heading.

Rice.—Paddy received from the Demonstration Plantation, Keravat, was planted in a half-acre block. The resultant crop has made good growth, but at present has not matured, although a fair yield is anticipated in the initial test on this crop at this altitude.

Indian Corn.—A quarter of an acre was planted in this crop and gave an excellent yield. Ample seed has been retained for further planting, and the balance fed to native labour. In addition, this makes excellent poultry fodder.

Ground-nuts.—*Rhodesian*.—As previous trials have proved, this variety is outstanding for local conditions, and has been grown to the exclusion of other varieties. One acre was planted, but at present has not been harvested.

Mungo Beans.—A variety trial is being conducted, but the crop is not mature.

Soy Beans.—*Otootan*.—As the area for crops was limited, and as a substantial quantity was in stock, this crop has not yet been established at Aiyura. But early planting in the new year is anticipated.

Sugar-cane.—The best varieties of local native canes have been collected and planted into a quarter-acre block. As sugar is an important item in local native diet, it is intended to establish a fairly large area under cane.

Cover Crops.—*Calopogonium mucunoides* has been established throughout the *Cinchona* and *Coffee blocks*. Local seed and cuttings have been used for propagation with equal success.

An acre of bush country has been planted under *Vigna catjang* for native food and green manuring.

A trial of *Tangier Pea* proved successful.

Vegetables.—Successful crops of the following vegetables were grown:—

Peas (Yorkshire Hero).

French Beans (Canadian Wonder).

Carrots, two Yates' varieties.

Cauliflowers, Sutton's Early Market.

Cabbage, Early Market.

Celery, Early White.

Cucumber, Long Green.

Parsnips.

Turnips, three varieties.

Turnip, Swedes.

Kohl-Rabi, Purple.

Onions, Bermuda Red and White; excellent size and quality.

Tomatoes, two varieties; excellent yield with no disease.

Lettuce, three varieties.

Endives, two varieties.

Radishes.

Mustard Greens.

Local seed from most of the above vegetables has been obtained.

Rodents.—The activities of rats, their large numbers and persistent attacks on all food crops, have become serious enough to warrant especial comment. The problem is complicated due to the fact that local natives eat rats even when found dead, and any poisoning campaign, although it would undoubtedly be effective in removing these pests, may lead to difficulties with local natives. Mechanical means of control would appear the only possible alternative, but the numbers captured in this way do not give an effective control. It is hoped that local natives can be trained not to indulge in eating rats found dead, after which a vigorous poisoning campaign can be conducted. This matter has been taken up with the officer in charge, Ramu.

Shade Trees.—An adequate supply of *Leucaena glauca* seedlings has been raised for permanent shade in the *Cinchona* and coffee blocks.

A successful strike of *Eucalyptus Alba* seed received from Cairns, Queensland, has been obtained and approximately 200 seedlings are established in the nursery. Likewise, 200 seedlings of *Pseudo Acacia* have been raised. Supplies of seed of *Eucalyptus rostrata* and *E. globulus* and *Acacia decurrens-baileyana* have just come to hand, and will be planted in the nursery shortly.

Reafforestation.—The need for a scheme of gradual reafforestation of the vast grasslands of the highland areas has been emphasized throughout the year. On warm days, natives casually walking about the countryside light fires wherever they may wander. Investigations have shown that this practice locally has no

other object than the removal of the grasses so that old enemies can more readily be seen. The idea that the countryside is burnt for rats can be definitely discounted, as any rats caught in the fierce flames are reduced to ashes.

As the year closes, it is pleasing to report that the Administration is likely to take action in arresting this gradual process of deforestation. Mr. McAdam, Forestry Officer, of Wau, has become impressed with the scheme and it is possible that nurseries for raising forest seedlings will be established here in the new year.

A scheme for the actual distribution to local natives of these forest seedlings when produced, and the more important work of establishment and subsequent care of them in the village lands, has been taken up with the officer in charge, Ramu.

Timber-sawing.—In November, 1937, work was commenced on pit-sawing local timbers. At first, progress was slow as indentured labourers had to be trained for the work. But at the close of the year approximately 5,000 feet of various hardwood and softwood timbers were in storage. In addition, 2,000 feet have been used for station purposes. The identity of the timbers selected for use is not known, but up to date four hardwoods and three softwoods have been found suitable for general building construction and furniture. Samples of these woods have been forwarded to Rabaul for inspection.

The timber supply available for this work is considerable. On the present station site, 500 acres of timber country will more than meet station requirements in the future.

Stock Prospects.—The possibilities of stock raising in this area are considerable, and offer great promise.

Various importations of stock to the Ramu area have been made during the year; the number of livestock owned by miners and Mission bodies having been increased by nine head of cattle and approximately 50 goats.

The S.D.A. Mission, Ramu, imported an Ayrshire bull calf of good type, and the Lutheran Mission, Onelunka, eight cows and heifers of Zebu cross.

A campaign against the introduction of cattle-tick has been conducted and all local residents are fully acquainted with the economic losses that must follow if this parasite is introduced. The cattle that have been introduced were inspected on arrival and found to be free of ticks. The District Officer, Salamaua, has given support to the campaign and a local regulation exists which makes an inspection of all cattle imported necessary, before they are admitted to the Ramu area and allowed open grazing. As it is almost certain that all cattle imported will be travelled in via the Lae-Markham Valley and as this station is the first one on the highlands, these precautions appear sufficient.

EXTRACTS FROM A REPORT OF A PATROL TO KUNUA AND HAHON SUBDIVISIONS, BUKA PASSAGE SUB-DISTRICT, KIETA DISTRICT.

By C. F. R. Gilbert.

In the course of the patrol six villages in the Kunua area were visited which had not previously been inspected by an Agricultural Instructor, Kunua and district having only been brought under full control in comparatively recent years. Very few regular coco-nut groves exist, but those that do were found to be clean and bearing well. The natives are still somewhat nomadic in their habits, and until fixed centres are established it might be advisable to defer any planting of coco-nuts on a large scale, as maintaining the areas in a satisfactory condition would present serious difficulties.

Several of the village officials at the more permanent centres appeared keen to plant coco-nut groves, and in these cases advice and instruction as to proper planting and spacing were given.

In the Hahon area, which has been permanently settled for some years, the groves, with few exceptions, were found to be clean, but it was obvious in many cases that this had only been done on the approach of the patrol, and had apparently been neglected for some little time past.

The palms in many cases were showing poor growth and not bearing well owing to having been badly planted in soil of a stiff clayey nature, and also probably due to neglect in the early stages of cultivation. In several villages where the palms had been well planted and cared for they were observed to be healthy and bearing well. All the well-known coco-nut insect pests common to the districts were found throughout both areas, but not in large numbers, although collections were taken at almost every village.

The main food crop of the natives of Kunua and Hahon is taro (*Colocasia esculenta*), supplemented by yams (*Dioscorea*) and bananas (*Musa sapientum*), and generally the gardens were found to be very satisfactory. Each village also had its quota of small patches of tobacco (*Nicotiana tabacum*).

The coastal belt extends up to 3 miles inland and contains several areas of volcanic soil with a good proportion of humus, the balance containing intermediate to rich loamy soil and sandy loam with humus. Numbers of clear running streams pass through these areas, but owing to the shifting sands at the mouths usually form into swamps near the sea shore.

Beyond the flat coastal belt to the east, the mountains rise fairly sharply and not more than a few acres sufficiently flat for commercial cultivation would be found. In this area the soil generally is argillaceous with a shallow surface of sandy loam on the slopes and rich humus in the valleys.

Apart from the cultivation of coco-nuts, there are certain areas which would be very suitable for the cultivation of cocoa (*Theobroma cacao*) and tobacco (*Nicotiana tabacum*). Labour would present little difficulty, as recruits could be obtained locally.

There is no harbour or safe anchorage south of Soraken and shipping would be a problem except in very fine weather. Soraken is a shipping point which can be used in all weathers, and it would be possible for a road to be constructed along the level coast line, but a number of bridges would be required. As the bulk of the native population is established further inland in the mountains, there are large areas in this coastal belt which could be taken up without causing them any hardship.

FROM PLANTER TO PRIME MINISTER.*

An article headed as above, from the pen of Mr. C. Ward-Jackson, appeared in the issue of the *Malay Mail* dated 20th October, 1938.

Realizing the special interest such an article would have for planters, Mr. Ward-Jackson has been good enough to amplify his article, by sending to us the following letters from Mr. Chamberlain, showing in close detail the sort of life the Prime Minister led as a planter.

In a letter written in 1890, he said—

"At 5 o'clock I get up, and after a cup of tea go down to the field, which is about three-quarters of a mile off. There I superintend the landing of lumber, and direct the men who are at work clearing. Sometimes, I take an axe myself, and do a little work, and this creates great enthusiasm. About 9, I go back home for breakfast, and then return to the field, where I have my lunch sent me at 1. At 4, I stop, go home to tea, after which life becomes unbearable by reason of the millions of mosquitoes, which necessitate the burning of 'trash' on the house floor until I go to bed about 8."

Here is the text of a letter written by him in 1894—

"Last week was one of the most severe I have ever had. On Friday, as if I had not enough to do otherwise, three schooners arrived with provisions and plants. Yesterday, as I had expected a heavy day's work, I told Arden to come and help me in the office, but early in the morning a vessel arrived with sisal leaves. From morn to dewy eve, I toiled away, not even stopping for lunch. By common consent we never had so many people here before. Another schooner arrived full of plants, and a vessel from the south end of the island full of people who brought island produce to sell, and wished to buy American provisions. About 9 o'clock in the morning Cash came to me for whisky, saying he felt faint. I had to take him up to the house, and leave him there all the rest of the day unable to do anything. Knowles and his whole family went off in the middle of the day to recruit, and a little later Johnson, the circuit magistrate, came to pay me a visit. Of course, being everywhere short-handed, the shop became absolutely packed. I had to go in myself, and lend a hand. We only served the bare necessities of life, and then shoved the people out by main force. Late in the afternoon another vessel came with leaf, and this morning yet another has come full of plants. The wharf was already piled high from end to end and the carts must be used for taking out leaf which cannot wait. Is not all this enough to turn one's hair grey? That mine has not is attested by the fact that my cash balanced exactly last night in spite of innumerable entries and cross entries, additions, and subtractions, heat, mosquitoes, and crowds of people."

* From *The Planter*, Vol. XIX. No. 10, October, 1938, p. 489.

COCKROACHES.

Disease to Humans.

There is no evidence to support the belief that cockroaches convey disease to human beings, it was stated in a health talk from the British Malaya Broadcasting Corporation station.

In Malaya the favourite breeding places for cockroaches are septic tanks which have not been properly sealed, and covered drains, it was stated. In both situations they are able to hide in a dark, humid atmosphere with plenty of food close to hand.

For this reason drains should never be covered over and septic tanks should be tightly sealed. If troubled with these pests it is always advisable to inspect the drains and the septic tank.

Traps baited with stale beer or pieces of peeled banana are of considerable use and can be made quite easily from jam jars or tin cans.

A cone of paper should be made and the tip of the cone cut off. The cone is then placed in the top of the jar or tin, after the bait has been placed point downwards so that once the cockroach has slid down the cone and entered the tin, it will have great difficulty in getting out again.

A piece of wood or cardboard should be placed to form a stairway from the ground to the rim of the jar or tin, so that the cockroaches can get to the top with ease.

A useful insect powder for use against cockroaches is three parts of sodium fluoride mixed with one part of powdered pyrethrum. This powder should be scattered about at night in the kitchen and other haunts of the cockroaches and swept up next morning.

The sodium fluoride is the important ingredient as it acts as a poison to the cockroaches. There are a number of cockroach powders on the market which contain sodium fluoride.

Powdered borax is also useful but it is not of much use to put it under the paper linings of drawers and cupboards. What we want to do is to persuade the cockroach to eat the borax and the best way to do this is to mix it with fine sugar or with powdered chocolate.

Borax can also be mixed with treacle and the mixture spread on pieces of tin or cardboard. The important thing is to mix the borax with an attractive food and to leave the mixture lying about in the cockroaches' favorite haunts.

Spraying cockroaches with a liquid insecticide is also of use, especially where the insects can be trapped in a cupboard or box.

The cockroach is found in all quarters of the globe and is important because of the damage that it does to food. It is not so much the quantity of food that it eats but the amount it spoils.

Besides spoiling food by fouling it with its excreta it taints everything with which it comes into contact. The "cockroachy smell" that it imparts to food and clothing is due to certain chemicals in its saliva and to a wax which is secreted by scent glands in its body.

The cockroach will eat anything from the whitewash on the wall to the best food in the house. It is especially fond of curry-stuffs, sweet foods and beer. It does considerable damage to boots and shoes and to books, especially the binding. It eats gum and paste with avidity.

Clothing is also attacked, especially if it is even slightly soiled with food.—*Straits Times*, 27th December, 1938.