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GREEN MANURING AND COVER PLANTS FOR COCO-NUTS.

By George H. Murray.

It has been proved, beyond question, by several Agricultural Departments and practical planters in tropical countries, that coco-nuts answer as readily to cultivation and fertilizing as any other crops in temperate or tropical regions.

In Ceylon, one of the most progressive tropical colonies of the British Colonial Empire, there are several firms which do a large business in the manufacture and sale of commercial fertilizers to coco-nut planters, competent managers, who would not commit themselves to the expenditure of money that did not result in increased profits. One gentleman with whom I discussed this matter locally, stated that cultivation and manuring of coco-nuts was "controversial", but there can be no gainsaying facts which have been repeatedly proved. Several planters, in the Territory, on the other hand have asked for the best kind of fertilizers to apply as top dressing in certain districts, but it would be almost useless to apply commercial fertilizers to a plantation covered with grass as the latter would be benefited at the expense of the coco-nuts.

Palms that have been circle-weeded could have suitable commercial fertilizers applied to them with benefit, and in many eastern plantations where it is still customary to graze cattle, and circle-weeding is practised, it is quite common to apply cattle manure or inorganic fertilizers. An estate known to me was, at one time, a decidedly poor yielder and the owners decided to carry out a systematic scheme for fertilizing with organic manure. All the cattle were penned at night and the manure scientifically composted each morning exactly as would be done on a well-managed farm in a temperate climate, even the poultry manure and other refuse being treated in the same way, and to-day that plantation is hardly recognizable as the same property that it was a few years ago. The crowns of the palms are all a healthy dark green bearing heavy crops of nuts, yet to use the words of the friend who accompanied me over the property, "ten years ago this was a poor estate". This improvement was only accomplished by carrying out a definite scheme of work over a period of years, but results proved that it was worth the labour, and if planters here would select a small portion of their plantation for experiment, using cover plants and circle-weeding for a radius of five or six feet, they could prove the question for themselves.

Naturally with slow-growing trees like coco-nut palms they could not expect immediate results, but there is not a shadow of doubt as to the ultimate benefit. The practice recommended by this Department for the use of cover plants is now becoming more general, but comparatively few planters are circle-weeding their palms, with the result that they complain that they cannot find their fallen nuts. Circle-weeding of sufficient radius enables the palms to obtain the full benefit of the application of both organic and inorganic manures, and most of the nuts will fall within the circle so weeded. In this connexion it might be stated that in a letter to me from the Government Chemist, Department of Agriculture, New South Wales, some years ago, he stated with reference to plantations in this Territory, "the practice of green manuring would be beneficial, but this necessitates the cleaning up of grass and weed growth, which I understand is not the general

practice". Recently I noticed on a small Mission plantation, that the ground had been hoed up, which was good as far as it went, and it was left in a fine condition for the sowing of cover plants, but such unfortunately had not been done. On a larger plantation a rotary hoe would be a very suitable implement for breaking up the ground prior to the sowing of cover plants, and if the planter would treat a portion of his property in this way annually, he would be able to deal with the whole arable portion of the plantation in the course of a few years.

It should not be forgotten that many of the plantations in this Territory, particularly in the Gazelle Peninsula, are 40, if not more, years old and that several are far from being in a healthy condition. Depreciation is rapidly going on and in a few cases it is rather doubtful if they can be brought into profit again. Rejuvenation is possible, provided the trees are not too far gone, but the more the growing point, or bud, becomes stunted the less likelihood there is of cultural methods being successful.

The soil on many of the older plantations, particularly in the neighbourhood of Rabaul, is lacking in organic matter, and the pulverised pumice of which it mainly consists is probably deficient in readily available phosphoric acid. Green manures (leguminous plants turned under) will supply the humus and the use of superphosphate would give beneficial results if applied in proximity to the tree, but the first consideration is to eradicate the kunai before manuring of any kind can be successful.

The value of green manure is not merely the supplying of elements lacking in the soil, but in improving the physical and mechanical condition of all classes of soil, heavy as well as light. The oxidation of humus resulting from the decomposition of green manures assists in rendering elements already in the soil more available as plant food, and has a stimulating effect on the activity of beneficial organisms present in the soil.

Green manures have one special property, organic matter, which they supply to soils and which is converted into humus, that essential without which no soil can be considered fertile. Artificial fertilizers can never replace organic manures (green or animal manure) because in order to be fertile soil must contain humus and be in a suitable mechanical condition essential for vigorous plant growth.

There is rapid diminution of organic matter in the soil of tropical countries and a regular replenishment is necessary to keep the soil in good heart. Even in countries where there are large numbers of cattle as in Ceylon and Java, animal manures are not in sufficient quantity for this purpose and green manures are used regularly for the supply of organic matter.

A factor of the greatest importance is that outbreaks of disease and serious attacks of insect pests are largely due to lack of organic manure and it was stated recently in *Nature* in a review of a standard work on Plant Protection that, "properly fed plants, like properly fed animals, would be largely resistant to disease, and the road to health is through organic protective foods". The use of organic manures for most tropical soils is necessary on account of leaching from heavy rains. The continued use of artificial fertilizers is no remedy, but, on the contrary, is liable to lead to evil consequences if not accompanied by adequate organic matter. Further than that, the nutritive and economic value of a crop

is enhanced by the use of an organic manure. However rich, therefore, the planter may imagine his soil to be, he should see that all animal and vegetable waste products go back into the land by systematic organic manuring, if the value of the plantation is to be maintained.

There has been a steady deterioration of the soils in many parts of the Territory for many years, because of incorrect agricultural practice, due to various causes; in certain cases to the lack of soil nutriment, in a few cases by rainfall erosion, and, in some of the low sandy island plantations where there is insufficient ground cover, by exposure of the soil to a tropical sun. It is now appreciated that some of these conditions can be improved by adding to the humus content of the surface soil by cultivating cover and green manure plants after which applications of artificial fertilizers can be employed to accelerate improvement and maintain a satisfactory balance between the cover plants and the permanent crop. Manuring, therefore, with artificial fertilizers is complementary to the development of natural or other cover plants in soil improvements.

Many of our plantations are on land that can be no longer considered virgin, having deteriorated for the reason noted above, impoverishment by kunai (*Imperata arundinacea*) and other noxious plants. Such soils require regeneration, otherwise there will be a steady decline in yield as can be noticed on many plantations already on poor, or even ordinary soils which have suffered impoverishment for years past. Soil deterioration is a world-wide problem which is now receiving attention in many parts of the world owing to the increase of the world's population and the consequent rapid utilization of land for various crops. It would appear from frequent statements heard, that the areas of land suitable for European cultivation in this Territory are almost limitless, but such is by no means the case. This might apply to a certain extent to native agriculturists who require only relatively small individual areas, but it behoves the European planter, therefore, that he should put the land on his plantation to the best possible use.

Many quotations could be given from the most reliable authorities to support these statements, but I will merely give one extract from a lecture on "Land and Land Use" by P. E. Brown, Head of the Department of Agronomy, Iowa State University, U.S.A., who states as follows:—

> "It takes 400 to 500 years to produce an inch of top soil which may be lost in one year on a steep slope, in three years on a moderate slope poorly managed, or in one rainfall of the cloud burst type".

We had ample demonstrations of this fact during the heavy downfalls of rain on the north coast, New Britain, when gullies were simply scoured out and some thousands of coco-nut palms were torn up by the roots, also in Rabaul itself, flooded with torrents of water because the surface vegetation had been covered up with pumice during the recent volcanic eruption.

I have elsewhere pointed out that the disappearance of certain ancient civilizations was due to the conversion of what were once fertile lands carrying a dense and highly civilized population, into deserts produced not by a change of climate, but by man's ignorance and lack of foresight in his treatment of the soil.

Soil conservation is of more importance in the tropics where the oxidation of organic matter takes place most rapidly. Prof. J. C. Lipman writing in *Science* of 24th January, 1936, states:—

"Amongst the major constituents of the soil whose importance we have under-estimated is the organic matter. It is not enough that a soil contains the essential ingredients for the production of plants. The soil must be able to absorb and to store sufficient quantities of water. This texture and structure should be such as to provide optimum conditions for the vertical and horizontal movements of the water and air. A good soil must furnish a source of energy to various micro-organisms which are a positive factor in crop production. Soil organic matter is a source of food and energy for micro-organisms".

It has elsewhere been stated in this periodical that there is a likelihood of a decrease in our copra production on several of the older plantations, and this also applies to certain plantations not so old, one in particular, which formerly yielded 60 tons of copra per month and is now only producing 27 tons per month, owing to the fact that the nourishment in its comparatively shallow soil is becoming exhausted. It is far easier to maintain soil in good order than to regenerate it once impoverishment has set in, and in those cases where the surface soil has been eroded by bad cultivation and lack of vegetal covering it has been rendered useless for all time. Tens of thousands of acres of land in the north-western States of America and Australia have been rendered practically valueless for this reason, and even in a new country like New Guinea, it is not uncommon to find where soil deterioration has set in through bad cultural methods. In this case the natives are amongst the worst offenders, fond as they are of making their gardens on steep hill-sides with the result that soil, particularly when of a friable nature, is carried into the valleys or gorges below, the noxious grass, kunai, then being the only vegetation able to get a footing on such a terrain.

The most valuable of all organic manures is of course animal excreta, particularly when properly composted. In Ceylon it is customary to maintain cattle on plantations largely for this purpose. They should be penned at night and the ground well provided with litter all of which is placed into a large concrete lined pit. When the pit is full it is turned into a second and finally into a third and by the time the first is again filled the compost in the third is ready for application to the trees. On certain plantations of a well-managed company in the Solomon Islands, the land is sub-divided into comparatively small blocks in which cattle are grazed periodically and in this way the grasses are kept down so that grass cutting by hand labour, so commonly seen in this Territory, is quite unnecessary. Incidentally the use of cattle in this way has been responsible for the spread of the valuable low-growing indigenous cover plant, sometimes known as Japanese clover (*Desmodium triflorum*), a cosmopolitan leguminous plant very common in the Solomon Islands and this Territory. Cattle eat it readily and ripe seeds pass through the animal and germinate in the voided excreta.

In plantations in this Territory herds of cattle are sometimes to be seen, but they are not grazed systematically, as in the Solomon Islands, or penned for manurial purposes, as in Ceylon, and are of little use in keeping down the grass if allowed free range over the whole plantation.

Selective Weeding.

The first step to put the soil in a healthy condition is to eliminate noxious growths like kunai, encouraging the growth of indigenous leguminous weeds of which there are many species, such as *Cassias, Desmodiums,* &c., and by the introduction of cover plants.

There are many indigenous leguminous plants, considered as weeds, to be seen in New Guinea, all of which should be encouraged to establish themselves on plantations. Some are of comparatively weak growth, and are, therefore, of less value than others, but all are beneficial and labourers should be taught to distinguish them from noxious weeds, so that they are not destroyed when cleaning the plantation. This is not a difficult matter, as thousands of primitive natives in Papua to-day are able to recognize leguminous plants which have been explained to them in their own tongues, as "friends of the coco-nut tree", and distinguished from other plants by mostly bearing pea-like blossoms and legumes or bean-like pods.

Amongst the most common of such plants is that usually known as "Grilly Plant", botanically as *Herpetica alata,* easily recognized by its candelabra-like influorescence. Wherever a large clump of this plant is growing it will be found that noxious grasses have been smothered out, and the surface of the ground beneath is cool and usually covered with a leaf mulch. Incidentally the plant contains a considerable quantity of chrysophanic acid, which renders it of value as a remedy for the loathsome native skin disease known as "Grilly", hence its popular name.

Crotolaria spp., particularly *Crotolaria striata,* is not uncommon in some plantations, having probably been introduced during the German régime as a green manure, for which it is much used in agriculture in other tropical countries. It grows about 3 or 4 feet in height, bears yellow flowers striped with brown, and legumes with a silky surface, about 1½ inches in length. It is not as rampant a grower as *Herpetica* (formerly *Cassia*) *alata,* but like that plant bears many nitrate bacterial nodules on its roots. There are many other species of *Crotolaria* easily recognizable by their seed pods, which rattle when the seeds are ripe, hence its generic name, which means "rattle box". The above and many species of *Cassia* are all of shrubby growth, but there are also creeping leguminous plants which should also be encouraged. Amongst the best of these latter is *Vigna marina,* a common littoral creeper in many parts of the Territory, and it was seen growing prolifically near the beach areas of a plantation on the east coast of New Ireland, where labourers were cutting it with "sarifs", as if it were a noxious weed like kunai. It forms a fairly dense carpet with creeping stems 6 to 7 feet in length, bearing small yellow flowers and should be encouraged, as it is likely to thrive in positions less suited for many other leguminous creepers.

Cover Plants.

In agriculture of the temperate zone, weeds are kept down by tillage with hand or draught implements, but this method is quite out of the question in the humid tropics, for many weeds are no sooner turned under than they start to grow again. (Tillage of course is practised in the tropics, where agriculture is

advanced, for aeration of the soil and other cultural processes.) In the place of tillage, therefore, the best system of preventing the growth of noxious weeds, is the cultivation of leguminous cover plants, which are also of manurial value.

In some countries, notably Ceylon, tall plants like *Tephrosia* are grown for this purpose and periodically lopped. The intensive methods of agriculture employed in Ceylon, however, would hardly be applicable on an extensive scale in a country like New Guinea, where cultivation is less advanced and labour less skilled. For that reason, the Department has recommended the use of leguminous creepers as cover plants, weeds in their own country, now commonly used on coco-nut and rubber estates in Malaya and elsewhere. The plants best suited for this purpose in New Guinea and which have already proved satisfactory, are the following:—

Calopogonium mucunoides.—This is one of the quickest-growing plants as a cover and forms a thick mat in about six months from sowing seed in the wet season. So rapid is its growth that one planter called it "galloping home", but it is apt to die back in a dry season, particularly if soil conditions are not altogether favorable. It forms a very dense, thick cover in good soil and the vines should be pulled back from the base of the palms for a radius of five or six feet.

Centrosema pubescens.—This has proved the best cover under most conditions. It does not form such a thick mat, as the above, but its tendrils pull down most noxious grasses and weeds when thoroughly established. It is not altogether successful with "Thurston grass" (*Paspalum conjugatum*) but, once established is permanent and does not require re-planting. It takes about twelve months to form a good cover from seed.

Pueraria javanica (*phaseoloides*).—This plant much resembles *Calopogonium mucunoides* in appearance, having hairy creeping stems, but the leaves are larger and even more vigorous in growth, so that it will even smother out "Thurston grass" and is equally effective in dealing with kunai. Its much ranker growth, however, requires more attention in keeping the circles round the palms clean. Like *Centrosema* it takes about twelve months to make a dense cover, but it is looked upon as one of the best cover plants for young coco-nuts at the Demonstration Plantation, Keravat. It does not seed freely and for a long time did not set seed at all at Keravat, consequently it is more expensive that other cover plant seeds. It is easily propagated by planting cuttings with adventitious roots at the nodes, or joints, so that once an area is thoroughly established it can be spread over the plantation. To economize the seed it would be well to plant it in a nursery first, to be planted in the field in clean ground, when sufficiently strong to hold its own. Planting cuttings should only be done in moist weather.

Method of Sowing Cover Crop Seed.

The best method of sowing cover crop seed is in mixture. The seed rate per acre depends entirely upon what the planter is prepared to spend. Up to 30 lb. per acre has been used in broadcasting on new land, but if the seed be sown in seed beds, much less will do. In a mixture of *Calopogonium* and *Centrosema*, 8 lb. of the former and 12 lb. of the latter has been recommended, but much less than that has produced a good cover on some New Guinea plantations, within twelve months.

In new plantations the cover plant seeds should be sown as soon as the land is cleared, before any grass or weeds can become established. On older plantations where grass and weeds are already in possession of the surface soil, clean beds, at least two feet in diameter, should be prepared about 6 feet apart each way. The seed should be dibbled or raked into the soil and given attention until the young plants start to send out climbing tendrils, when they can battle for themselves, and will eventually form a dense cover over the plantation.

Cover plants, being leguminous, are of value for green manure and when thoroughly established it is advisable, when possible, to turn them under every few years. The "cover" should be "sarifed" about twice a year, or it would be still better if it could be disced with a disc harrow or rotary hoe, which would have a beneficial effect in providing air for the roots, an essential for plant growth. It should also be remembered by those proposing to apply artificial or inorganic fertilizers that they are much more effective on soil comparatively rich in organic matter than on soils that are poor in such elements.

Grazing Value.

For those planters who carry stock on their properties, *Centrosema* in particular will be found very good grazing, but due care must be taken, otherwise there is danger of stock eating it out. For this and other reasons previously noted, all plantations carrying stock should be subdivided, and if worked systematically stock-raising could be made a valuable adjunct to the copra industry.

CORKS.

Various Household Purposes for which they may be Utilized.

An ordinary "wine" cork makes an excellent door-stop if a screw is driven through to secure it to the floor. The cork will not be conspicuous if coloured with household enamel to match the floor or walls of the room.

A cork screwed on to a kettle or pan lid serves as a convenient and non-conductive knob.

When a cork seems to be too big for a bottle it can be made to fit by soaking it in boiling water for a few minutes. To render a cork air-tight and water-tight, soak it in olive oil for five minutes before use.

To prevent the risk of a cork coming out of a bottle when travelling fix a strapping of adhesive plaster over the top, or tie over the cork the finger of an old glove.

INSECT PEST CONTROL.

By John L. Froggatt, B.Sc., Entomologist.

Elaboration of methods for the control of insect pests is not merely a question of the haphazard use of insecticides, the action of which can only be more or less guessed, but demands a considerable amount of careful detailed study of the life history and habits of each pest before any question of the method of control to be used can be raised. There are certain broad lines of control that may be applicable to certain groups of insects, but variations in habit and local conditions will often necessitate adaptation of such to special cases.

A thorough knowledge of the life history and habits gives data on the length of the life cycle (deposition of egg to emergence of adult); where the eggs are deposited; where and when the larvae feed—whether they are internal or external feeders; where the adults shelter and where and when they feed; any indigenous parasites, and at what stage of development of the host they are operative, and their economic importance. With this data in hand, the research worker is able to decide whether one stage of development is more vulnerable than another, what line or lines of attack offer the best possibilities of success, and how to set about their application.

In relation to plant life, insects may be divided into three classes;

(i) those which obtain nourishment by chewing (caterpillars, &c.);
(ii) those which, by specially adapted mouth parts, puncture the bark, and suck up the sap (plant bugs, aphids, &c.);
(iii) those which feed on other insects.

The first two form the pest groups (i.e. insects which interfere with agricultural production), while the third comprises insects of great value to man. It is obvious that the two pest groups require the application of very different methods for their control.

The general lines on which control may be considered are:—

(i) *Mechanical measures*; the use of insecticides by dusting, spraying or fumigation.
(ii) *Biological measures.*
(iii) *Variations in agricultural practice.*

Mechanical Measures.

There are a number of chemicals, and preparations of such, that can be used either as sprays or dusts, and are classed as:—

(*a*) stomach poisons, for chewing insects.
(*b*) contact insecticides, for sucking insects.

Of the *stomach poisons,* mention may be made of Arsenate of Lead, Calcium Arsenate, Barium fluosilicate, Paris green, Derris and Pyrethrum preparations, and of the *contact insecticides,* Lime-sulphur spray fluid, Kerosene emulsion, Miscible-oil sprays, Derris and Pyrethrum preparations. For fumigation, Hydrocyanic acid (Prussic acid) is the gas most in use, although Carbon disulphide and other chemicals have certain uses.

In the case of mechanical measures to be adopted, the type of insecticide is decided on. The next step is the method of application, either spraying, dusting, baiting or fumigation.

Spraying is a measure in which the insecticide is mixed with a fluid as carrier (usually water), and projected over the crop in the form of mist, the fluid running off and leaving the insecticide as a fine film over the plant.

Water used for this purpose must be soft (i.e. lather easily with soap), as hard water (i.e. does not lather easily with soap, but forms a hard precipitate) will cause chemical change when used with some chemicals; therefore if the only water available is hard, it must be treated with soft soap or soda-lye to eliminate the chemicals causing the hardness.

Where the area to be treated is large, water in sufficient quantity may present considerable difficulties, and add considerably to the cost of operations.

Dusting (sometimes called dry spraying) consists of the projection of the insecticide into the air as a fine dust-cloud, allowing the natural air currents to carry the powder through the crop, the dust slowly settling as the cloud travels onwards. Much larger areas can be covered in the same time and with less labour by this method, which has largely superseded spraying for most purposes; furthermore the difficulties of sufficient supplies of soft water and costs of cartage are eliminated.

Baiting consists in treating some suitable material with poison and setting it out as baits for the insects to feed on, on and around the feeding grounds.

Fumigation requires a gas-proof container, into which the plants and materials to be treated are placed and subjected to the poison gas for a given period.

The next step in the investigations is the setting up of a series of comparative trials with the insecticides selected to determine which preparation gives the best results with a minimum of cost consistent with efficiency, and without damaging the crop. These tests are made on a small scale, and, on completion, lay the foundation for field trials.

Biological Measures.

In biological control, advantage is taken of the assistance of insects which prey on others, either internally or externally. There are two groups of these friendly insects; those which confine themselves to one individual of the host (parasites), and those which wander from one member to another of the host (predators). Of the former, some are parasites of eggs, others of larvae, and still others of the adults of the host. Some are more or less specific in their host relationships, while others are found over a wide range of hosts.

Where indigenous parasites and/or predators are absent, or of little economic value, it may be advisable to consider the introduction of such from foreign countries. In these cases the very greatest care must be taken to prevent the introduction of any insect that may, under the new conditions, become a pest, or even a hyperparasite of some economically useful insect already present in the country, or even of the useful insects it is desired to introduce. Careful detailed study, preferably in the country of origin, is required for these purposes, and the breeding of the parasites through two or more generations may be necessary, should hyperparasites be present, to ensure a pure strain.

Biological control may be slow in its initial stages, while the parasites become acclimatized, but if successful will save a great deal of labour and expenditure of money, for once established it requires no further attention.

Agricultural Practice.

It has been stated that healthy, vigorous plants are not subject to infestation by pests and diseases. Although many consider this as rather too sweeping a statement, there is no doubt that a vigorous healthy plant will not be affected as badly by pests as one of low vitality.

It has been proved time and again that proper attention to agricultural practice has a very important bearing on pest and disease control.

When a crop is affected by soil frequenting insects, cultivation of other crops on that area for a period will assist in starving out the pests. A system of crop rotation may even be sufficient.

Cultivation and manuring will assist in forcing growth, and minimise damage by some foliage feeding insects, in addition to improving the general vigour of the crop.

Due attention to plantation hygiene can lead to the removal of breeding grounds and sheltering sites of many pests.

Field Practice.

In actual practice, field trials may prove that control of a pest may be more satisfactorily obtained by a combination of two or more of these lines of attack.

General Insecticides.

A few notes on general insecticides used against plant pests may act as a guide in treating common pests as they arise.

Leaf Eating Insects.

For Spraying, Arsenate of Lead, Paris Green, Derris and Pyrethrum preparations.

For Dusting, Arsenate of Lead, Calcium arsenate, Paris Green, Derris and Pyrethrum preparations.

Sap-Sucking Insects.

Kerosene emulsion, Derris and Pyrethrum preparations, Lime Sulphur fluid, Miscible Oils, Black-leaf 40 (Nicotine sulphate), and Resin wash are some of the more general sprays, depending on the pest to be treated.

Arsenate of Lead.

This insecticide is obtainable in two forms, powder and paste. With the former, it is advisable to use some preparation that will assist the poison in spray form to adhere more strongly to the foliage, referred to as a "spreader" or "sticker."

The paste form has the sticker already mixed with the poison.

For spraying, Arsenate of Lead is used at the rate of 1½ lb. of powder or 3 lb. of the paste to 50 gallons of water. When preparing the material, it should be worked up with a little water into a thin paste free from lumps; this is then poured into the full quantity of water, stirring constantly. As the poison is only in a state of suspension, the apparatus used for spraying must be equipped with an efficient agitator to prevent the powder settling out, on to the bottom of the container.

Used as a dust, Arsenate of Lead is usually mixed with hydrated lime or other inert filler in the proportion of one part of poison to three to ten parts of lime.

This insecticide has certain advantages over other arsenicals in that it is comparatively safe to use on foliage; it adheres fairly well to foliage, and when used as a spray it does not settle as rapidly as, e.g., Paris Green.

The usual spreader used with Arsenate of Lead is:—*Calcium Caseinate,* or *Casein-Lime* at the rate of 2½ oz. to 50 gallons of spray mixture.

This preparation can be made by mixing thoroughly 3 oz. of *Powdered Casein* with 7 oz. of *Hydrated Lime.* The ingredients may be added to the spray in the dry form, or first mixed into a paste with a little water, and then added to the spray. When added in the dry form, it should be done slowly while the agitator is in motion.

When the mixture is first made into a paste, the two powders must be thoroughly mixed together dry, and water added in small quantities stirring vigorously until chemical combination takes place. When this is complete, the thin paste can be diluted with water for convenience in handling, and the necessary amount added to the spray.

Calcium caseinate has advantages over other stickers in that it is compatible with all sprays, is convenient to handle and low in cost, and does not cause injury.

Paris Green.

This poison has a much more rapid action than Arsenate of Lead on insect life, but there are several reasons why it is not used more extensively; used as a spray, it settles much more rapidly, and therefore it is difficult to keep an even strength of spray through the nozzle; it does not adhere as well to the foliage, and thus necessitates more frequent spraying; furthermore it may contain an appreciable amount of water-soluble arsenic, which will burn the foliage: (this can be overcome by the addition of lime, which combines with the soluble arsenic, and reduces the risk of damage to the foliage); the greater cost as compared with other arsenicals.

For spraying the poison should be worked up into a thin paste without lumps by the addition of small quantities of water; the lime should be slacked in a little water and added to the full volume of the spray; finally the Paris Green is added. The regular formula is—

Paris Green	½ lb.
Quick lime	1 lb.
Water	50 galls.

Paris Green may be used as a dust, mixed with hydrated lime in the proportions of 1 part of poison to 6—10 parts of Lime.

This insecticide is used extensively in a bait for "cutworms", which shelter in the soil during the day, and come out to feed at dark. The general formula for this bait is—

Bran	50 lb.
Paris Green	2 lb.
Molasses	2 quarts.
Lemons	3 fruit.
Water	4 galls. (approx.).

The Paris Green is thoroughly mixed with the dry bran; the fruit is chopped up and added to the water with the molasses. The fluid is then stirred into the poisoned bran to form a damp, slightly crumbly product.

It is more satisfactory to mix the bait during the day, and scatter it on the ground at the base of the infested plants in the late afternoon, so that it is fresh when the caterpillars come out to feed about dusk.

Calcium Arsenate.

This is a light flocculent powder that offers possibilities in certain cases of dusting.

Derris.

The roots of certain Derris spp. contain chemical bodies that are very toxic to some forms of insect life, but are much less poisonous to mammals than arsenicals. A great deal of attention has, therefore, been paid to preparations in which Derris extractives are the active principle. Against caterpillars, this insecticide appears to be very satisfactory, and for dusting and spraying of vegetables has largely replaced arsenical preparations.

Pyrethrum.

Research in recent years has shown that there are greater possibilities in Pyrethrum preparations than had been heretofore realized.

This insecticide is derived from the ground-up flowers of a plant, *Pyrethrum spp.*, belonging to the Chrysanthemum family, and although very toxic to insects, has little or no harmful effect on warm blooded animals.

Resin Wash.

This spray is specially useful for scale insects on citrus trees. A formula recommended in New South Wales is:—

Caustic soda, 98% quality	5 lb.
Resin	16 lb.
Soft soap	6 lb.
Water	100 galls.

To 10 gallons of boiling water, add the above quantity of caustic soda; slowly add the resin (which must be first finely powdered) a little at a time, stirring constantly; then add the soft soap little by little, still maintaining a constant stirring of the fluid; boil the whole together from two to three hours, or until well dissolved. Add hot water, a little at a time, until there is not less than 20 gallons of hot solution. Keep well stirred. Dilute in the proportions of 4 gallons of hot water to one gallon of *hot* solution, or so as to bring the whole up to 100 gallons. *Never add cold water when cooking.*

If obtainable 3 pints of fresh oil would be preferable to the soft soap.

The concentrated solution can be kept for some time as a stock solution and diluted for use as required.

The solution should be used as hot as the hose can stand without damage, for, if allowed to cool, the spray may interfere with the valves of the pump. As it comes in contact with the air in the form of spray, the mixture will be cooled to such an extent that no harm will be done to the tree.

In spraying, see that the inside of the tree is reached as well as the outside, and the under—as well as the upper—surfaces of the leaves.

This spray will be found most effective when applied to the trees when the young scales are hatching out from the mother-scales. This must be determined by observation.

Should the trees be suffering from the effects of droughty conditions, it is not advisable to apply this wash, as it would destroy the foliage, and thus injure the tree.

Kerosene Emulsion.

The stock formula for this emulsion is as follows:—

Kerosene	2 galls.
Whale oil soap	½ lb.
Water	1 gall.

(One quart of soft soap may be substituted for the whale oil soap). The soap is first finely divided and dissolved in the water while boiling; when dissolved immediately remove from the fire and add to the kerosene. The whole mixture is then violently agitated while hot by being pumped back into itself with a force pump and a direct charge nozzle throwing a strong stream, preferably ⅛th inch diameter. After 3 to 5 minutes pumping, the emulsion should be perfect and the mixture will have increased from one-third to one-half in bulk and assumed the consistency of cream. Well-made emulsion will keep indefinitely, and should be diluted only as wanted for use. The use of whale-oil soap, especially if the emulsion is to be kept for any time, is strongly recommended, not only because the soap possesses considerable insecticidal value itself, but because the emulsion made with it is more permanent, does not lose its creamy consistency, and it is always easily diluted, whereas with most of the other common soaps, the mixture becomes cheesy after a few days and needs reheating to mix with water.

Soft soap answers very well, and one quart of it may be taken in lieu of the hard soaps. In limestone regions, or where the water is very hard, some of the soap will combine with the lime or magnesia in the water, and more or less of the oil will be freed, especially when the emulsion is diluted. Before use, such water should be broken with lye, or rain water employed.

For spraying, thoroughly mix one gallon of the above stock with 7 gallons of water.

Where only small quantities of the spray are required, the following formula may be used.

Water (1 kerosene tin full)	4 galls.
Sunlight soap	2 cakes.
Kerosene (good quality)	1 pint.

Emulsify the kerosene as above and spray with the liquid with just the chill off.

Miscible Oils.

In these preparations, the oils are so mixed that they are readily miscible with water; they are of two types, one for trees in a dormant condition (i.e. without foliage) and the other for trees in full growth; only the latter type are applicable to this Territory.

Against scales and mealy bugs, certain of these oil sprays have given good results.

Lime Sulphur Spray Fluid.

This is not only an excellent insecticide, but is also an important fungicide.

This spray fluid can be obtained in a concentrated form that only requires diluting with water, according to the directions supplied by the manufacturers.

The preparation can be made on the plantation, but is an unpleasant and tedious business; the field formula is as follows:—

Flowers of Sulphur	100 lb.
Good burnt lime	50 lb.
Water	50 galls.

About half the water is brought to the boil, and the lime stirred in while heating; the sulphur is mixed into a paste and added and the liquid stirred until the lime is well slacked and the contents thoroughly mixed. The remainder of the water is then added, and the whole boiled for three-quarters of an hour to one hour, but no longer. The liquid, orange red in colour, is strained to clear out any sediment, and stored in airtight containers.

The dilution of the solution depends on its density, the determination of which is done by means of a Baumé hydrometer, from which the density is read off in degrees Baumé. The appended chart will enable sprays of correct dilution to be prepared from lime-sulphur concentrate of various densities. First determine the density of the lime sulphur to be used; find the corresponding density in the left hand column. The figure in the same horizontal line in the column headed by the dilution required will give the amount of water to be added to one part of the stock solution in order to give the required dilution.

*Density of Stock solution in 0° Baumé.	Dilutions Required, Based on a 33° Baumé Standard.							
	1-10.	1-15.	1-20.	1-30.	1-40.	1-80.	1-100.	1-120.
25°	7.6	11.4	15.2	22.7	30.3	60.6	75.8	90.9
26°	7.9	11.8	15.8	23.6	31.5	63.0	78.8	94.5
27°	8.2	12.3	16.4	24.5	32.7	65.5	81.8	98.2
28°	8.5	12.7	17.0	25.5	33.9	67.9	84.8	101.8
29°	8.8	13.2	17.6	26.4	35.2	70.3	87.9	105.5
30°	9.1	13.6	18.2	27.3	36.4	72.7	90.9	109.1
31°	9.4	14.1	18.8	28.2	37.6	75.2	93.9	112.7
32°	9.7	14.5	19.4	29.1	38.8	77.6	97.0	116.4
33°	10.0	15.0	20.0	30.0	40.0	80.0	100.0	120.0
34°	10.3	15.4	20.6	30.9	41.2	82.4	103.0	123.6
35°	10.6	15.9	21.2	31.8	42.4	84.8	106.1	127.3

* Diseases and pests of Queensland fruits and vegetables—Veitch and Simmonds.

Spraying and Dusting Apparatus.

The type of apparatus required for any particular area will depend partly on the nature of the crop, and partly on the area to be treated.

For small garden or nursery areas, hand dusters and sprayers are obtainable at low cost, while a range of machines up to large power plants, sufficient to do any class of work, are quoted by a number of manufacturers.

When spraying with poisons which are only held in suspension in the fluid, such as Arsenate of Lead and Paris Green, an agitator is required to keep the mixture in constant movement and maintain an even strength of spray.

Advice on these matters will be freely given to any one desiring information; when inquiry is by letter, the fullest information should be given on the nature of the crop to be treated—low or high, and if the latter, the range of height—area, &c.

DISEASES OF PIGS.

By G. F. Gee, H.D.A.

Pigs kept under clean conditions, receiving a balanced ration, and provided with dry, draught-proof sleeping quarters, are susceptible to very few serious diseases.

Most diseases can be traced to bad housing, badly-drained land upon which they run, or a ration which is unbalanced, i.e., the per cent. of proteins to carbohydrates and fats, in the ration being fed, is either too high or too low.

Provided that all these factors are given proper attention and the strain of pigs kept are the right type, little difficulty will be experienced in bringing the pigs to maturity in the shortest possible time.

It must be remembered that when a young pig becomes affected with a disease of heavy infestation of parasites, its growth is seriously hampered, and it is rarely worth while attempting to rear it to maturity, as the time taken and the extra food consumed makes it uneconomical.

Following is a list of the more important diseases to be met with by the pig breeder.

Contagious Pneumonia.

This disease causes heavy losses among pig breeders, and once established in a piggery is highly infectious, and spreads rapidly from affected to healthy pigs.

It is caused by a bacillus. The organism responsible can remain alive for several months under favorable conditions, but is easily killed if due care is given to hygiene, and disinfectants used. Pigs of the weaner or store type are usually affected.

Symptoms of the disease are as follows:—

Pigs affected have a high temperature and have great thirst, with a tendency to lick up anything wet. They become sleepy and dazed, and lose all inclination to eat. The gait becomes unsteady, and often the hind legs wobble. The pigs seek quietness, rest, shade and water. A sticky discharge appears from the eyes, to which dust adheres, and the eyes may become glued together. The pigs become emaciated, the ribs and spine becoming prominent and the flanks tucked up.

Diarrhoea and constipation usually alternate, the foeces are discoloured, sometimes contain blood, are putrid and usually adhere to the buttocks. Ulcers may appear in the mouth and a state of pneumonia is present. The animal has fits of dry coughing, and sits on its haunches breathing very rapidly and shallow. There is a heavy pumping movement of the body, which gives the popular name of "Pants" to the disease. Red spots may appear on the body, especially on the underline, ears, neck, breast, and on the abdomen, where it runs underneath the groin. These are more readily noticed on white pigs than on pigs of a darker colour.

Post-mortem inspection shows the lymph glands to be slightly darker than usual, and the lung has a marbled or mottled appearance.

Predisposing causes of the disease include exhaustion, cold or continued wet weather, unbalanced rations, contaminated water supply and general insanitation.

Prevention and suppression of the disease consists in taking the following precautions:—

Keep any new or visiting stock separate and under observation for at least four (4) weeks.
Isolate all sick pigs.
Disinfect all sties, houses, &c.
Undertake sanitary measures daily.

Swine Fever.

As far as is known, this disease is not present in the Territory, but when once introduced may rapidly wipe out large numbers of pigs in a very short time.

It is an extremely contagious, virus disease (i.e., caused by an ultra microscopic organism) favoured by insanitary conditions and improper feeding. It usually affects suckers or stores up to three (3) months of age, but rarely affects older pigs. Death may take place in as short a time as two to three hours.

The temperature rises rapidly, and may go as high as 106°-107°. The pulse and heart rate become very quickened, while the respirations are quick, increased and shallow. The pig may also exhibit a short, dry cough, and be greatly affected by prostration, often bleeding from the nose, due to excessive coughing. Red spots similar to those caused by contagious pneumonia may also appear. These are due to the action of the virus organism on the nervous system.

The pigs become constipated or otherwise, have a tendency toward tympany (bloating). Death usually then follows.

Method of infection may be either by ingestion or respiration, but more usually by ingestion.

A common cause is the feeding of uncooked meat from a diseased animal to healthy animals. The period of incubation may range from one to three weeks from time of ingestion till the first symptoms are noticed.

The disease may be spread by—

(1) Contact with affected pigs or material.
(2) Sound pigs occupying sties previously occupied by affected pigs.
(3) Introduction of boars and sows for breeding purposes.
(4) Germs carried from one piggery to another by attendants, &c.
(5) Birds (crows, &c.) and flies may carry the germs from an affected piggery.
(6) Stock may carry the germs on their feet.
(7) Prevalence of rats.
(8) Contact with any discharge from an infected pig.

Post-mortem lesions show very little, although blood spots may be noticed in the musculature and kidneys, while the lymph glands are usually darker than usual.

There is no effective remedial measure, and prevention by proper attention to hygiene and suitable rations is the only thing.

Inoculation may be practised, but an inoculated pig, due to the method of inoculation, becomes a carrier, so that all pigs in a district must be inoculated. In addition, up to three (3) per cent. may be lost.

Tuberculosis.

This may be regarded as a serious disease of pigs in the Territory, and many have been seen suffering from it, some badly affected.

The disease is caused by pigs ingesting material from an infected source, as milk or meat. It may also be caused by inhalation, but ingestion is the more common method of infection.

The most common glands affected are those of the head and throat, the glands of the digestive tract are next affected, followed by those of the lungs, while the spleen may often be affected. Occasionally, the bones and even the udder and mammary glands become infected. The pigs become unthrifty, or there may be no outward signs of the disease. If infection is suspected, the pigs should be tested by tuberculin, using the Opthalani test, which gives indication of the presence of the disease.

Post-mortem examination shows the lymph glands to be enlarged, and containing a grey, gritty pus. It is very easy to determine the presence of tuberculosis on post-mortem inspection; therefore, all pigs killed for human consumption should be examined for presence of the disease.

The glands inspected are the submaxillary and the precrural lymph glands. The submaxillary are found one on the point of each jaw, and are cut on to from inside the carcass. The precrural are situated one in each groin, and if these are found to be affected the whole carcass should be condemned. If only the submaxillary are affected, then the head should be condemned.

The main source of infection of tuberculosis to the pig is cattle. Where possible, pigs should not be allowed to run in the same paddocks as cattle, and all milk, fed to pigs, should be sterilized before feeding.

All slaughterhouse and household refuse should be well boiled before being given to pigs.

Poultry may also transmit tuberculosis to pigs, and for this reason the two should not be run on the same ground. Tuberculosis in fowls is most easily recognized by enlargement and sponginess of the bones.

All houses and feeding places should be regularly disinfected to prevent the possibility of spread of the disease. There is no known remedy for tuberculosis; prevention is the aim.

All pig flesh should be well cooked before being consumed, as the organism is destroyed by prolonged high temperatures. It is considered that much of the tuberculosis in the Territory is caused by the consumption of undercooked pig flesh which appears to be the usual method in most parts.

Anthrax.

This disease in pigs is caused by the same organism that causes anthrax in other animals, but it affects pigs differently, except that death usually takes place very rapidly.

The pig has a fever of up to 106° F., there is a swelling in the throat due to the bacilli being located in the lymph glands there, and the face swells up and the eyes appear to sink.

Pressure from this swelling causes short, difficult, rapid breathing, and owing to the distress, the animal gets diarrhoea and finally chokes.

Post-mortem inspection shows little, except swollen lymph glands.

The carcass of a beast which has died from anthrax should never be opened up, but should be burned on the spot without being moved. An alternative is to bury the carcass at least 6 feet deep, as earthworms can convey the spores to the surface if not buried deeply enough. Spores can exist from fifteen to twenty years under favorable conditions.

Suppurative Otitis.

This disease is most common in young pigs, and is marked by the peculiar carriage of the head and unsteadiness of gait, the part affected being the ear.

The ear is divided into the outer, middle and inner ear. The outer ear collects the sound waves and transmits them to the drum. The middle ear is on the other side of the drum, and it exaggerates the sound waves, which are then passed to the inner ear. This is connected with the brain.

A tube, known as the Eushachian tube, connects the middle ear to the nose, and this serves to maintain equal pressure on both sides of the drum. Mucous and other discharges from the ear also pass down the tube to the nose.

When suppurative otitis occurs, an abscessed condition is set up in the middle ear, while the outer ear is not affected. This interferes with equilibrium and sense of direction by breaking down the maintenance of equal pressure. Being situated in the middle ear it is practically impossible to treat it.

The head is rotated to one side, and is often twisted. In bad cases the drum may burst, and there is a pussy discharge from the ear. There may be often a discharge from the nose which is a form of nasal catarrh.

There is a possibility of the disease being contagious, although this has never been proved, but it is advisable to isolate any affected pigs.

Pigs in any condition may be affected by the disease, and when affected the hair may lose its lustre, and the skin may become scurfy; but this is not always the case.

The only treatment to be adopted is to syringe out the external ear with a weak solution of hydrogen peroxide.

Heat Apoplexy.

This condition is more likely to affect fat pigs, and only occurs in hot, sultry weather, and in pigs subject to the direct rays of the sun.

The condition consists of convulsions in the pig due to pressure within the brain. The blood vessels become dilated, but still intact, so that recovery is rapid, or the blood vessels may become ruptured, which brings about death.

Prevention, as far as possible, by good management, feeding and hygiene, should be aimed at. The action of the bowels should be kept under observation, and purgatives administered when necessary. Glaubers salts (3–4 tablespoons per 100 lb. live weight) should be given, olive or linseed oil (4–8 oz.), or castor oil (2–4 oz.) are all satisfactory.

Where possible, if symptoms are shown, hose the pig down or throw buckets of water over him, being careful to wet the head first and then the rest of the body.

Abortion.

This condition in sows may be either sporadic or contagious, due to a bacillus. The bacillus, however, has not yet been proved to be identical with that causing contagious abortion in cattle.

Predisposing causes of sporadic abortion include—

Insufficient exercise, which causes overfatness and a toxaemia which causes abortion.

Incorrect feeding of pigs; a necessary portion of the ration is missing.

Feeding indigestible foods, or pigs becoming constipated.

Feeding too much fat to pigs, especially household scraps not cooked.

Driving pregnant sows hard, or long journeys, rough handling, or crowding together in sleeping quarters.

Debilitating diseases, as pneumonia or swine fever.

Once a sow has commenced to abort (i.e., swelling of the vulva or dropping in the hams) it is practically impossible to prevent it. A quarter (¼) to one (1) teaspoon of laudanum per 100 lb. live weight may help in some cases. If the sow is constipated give her a drench of 3-4 tablespoons of Glauber salts in water per 100 lb. live weight.

Preventive treatment lies in correct management, and feeding, quietness for pregnant stock, segregation of stock into sties, and the maintenance of clean, hygienic surroundings.

Catarrh.

This disease is also known as "snuffles". It is an inflammatory condition of the mucous membrane of the respiratory parts of the head—the nasal cavity, frontal sinus, &c.—causing an increased supply of lymph, which blocks up the apertures and causes snuffles.

The pigs are affected by a short dry cough due to the distress and the inflammation of the larynx and pharynx, which causes laryngitis and pharyngitis. The condition extends down the trachea and turns to bronchitis, which causes the cough to become quicker and more rapid. If the lung substance becomes affected the condition gives rise to pneumonia.

The disease is caused by wet, exposed, unhygienic conditions, especially draughts and cold winds, or chills due to incorrect flooring. There is always a tendency towards catarrh in continued wet weather.

All affected pigs should be isolated and the food should be correctly balanced, nutritious and not constipative.

If the pig becomes constipated, dose with olive or linseed oil (4–8 oz.) or castor oil (2–4 oz.).

Chlorate of potash at the rate of half (½) teaspoon in water for 100 lb. live weight, may also be given in the drinking water.

Scours in Young Pigs.

This condition is usually due to the sow's milk, the fault being either in feeding or the management, or even a diseased condition of the sow.

If the latter is the case it is necessary to take the young suckers away from their dam.

Too much fat in a young pig's ration will also cause scouring, as will unhygienic conditions, which rapidly bring on diarrhoea.

In treatment, the first essential is to remove the cause, and to pay particular attention to management and feeding.

Prepared chalk and powdered charcoal mixed in equal quantities, and given at the rate of one (1) drachm in the feed will relieve the condition.

Very good results have been obtained by diminishing the amount of feed given to the sow and cutting out all greenstuff from the ration, it being replaced by a little whole dry maize. With this treatment suckers have been cured of this condition in two to three days.

Gastritis.

This is an inflammatory condition of the stomach due to the ingestion of fibrous foods, sand or poisonous substances as brine, arsenic or phosphorus.

The pig shows signs of great uneasiness and loss of appetite. It attempts to vomit, and stands with its back arched, tail drooped and ears back. A fever is present, and there is evidence of great thirst. After two or three days the pig either becomes constipated or has diarrhoea; or if the condition persists, the two alternate.

Treatment lies in good nursing and tempting the pig with easily digested swill. Add half an ounce (½ oz.) epsom salts or half an ounce (½ oz.) hyposulphite of soda, daily to the drinking water, which will keep the temperature down. In addition, give castor oil, one ounce (1 oz.) per 100 lb. live-weight, in milk, three (3) times daily, till the bowels function normally.

If the pig has diarrhoea, give one (1) drachm chlorodyne and 15–20 grains baking soda in milk, several times daily till the condition ceases.

Soapy water enemas will also help.

If the gastritis is due to brine poisoning, in addition to other symptoms, the pig usually froths at the mouth, races round bumping himself, and may even go into convulsions.

In this case an emetic is necessary, so give 15 grains zinc sulphate in water. Follow this with olive or linseed oil, 4–5 oz. per 100 lb. live weight. Add one (1) drachm laudanum and chloradyne to the oil and repeat this sedative four or five times daily, in milk.

If the gastritis is due to phosphorus, on no account give oil, but give either one (1) drachm turpentine or half (½) drachm of copper sulphate, in a flour gruel.

Mammitis.

This is a germ infection of the udder and is brought on by contact with dirty floors and pens, or cold damp quarters. It may also be caused by overfeeding a sow of high milk production.

The udder becomes swollen, inflamed and tender. In advanced cases it becomes hard, swollen and lumpy or lobulated, and even containing pus.

The condition can be prevented by avoiding the cause—strict hygiene in the pens and careful attention to the sow's rations.

If from over milk-production, reduce her feed and give an increased amount of salt in the ration, which will have the effect of drying her off.

Relief may also be given by massaging the udder with an embrocation made up of—Camphor, 1 part; soft soap, 1½ parts; turpentine, 13 parts; boiled water, 4½ parts.

The soap is dissolved in the water, and the camphor in the turpentine, the two solutions mixed and well shaken.

Sow Eating Young.

This condition can usually be traced to improper feeding, the ration usually being deficient in protein, so that the sow is meat hungry.

It is marked by an extremely feverish state and abnormal appetite after farrowing; the sow may even become ferocious toward her attendants.

To overcome the possibility of a sow eating her young after farrowing, it is essential to balance her ration properly during pregnancy, seeing that she receives sufficient protein, by feeding meat meal if necessary, to make up for the extra drain on her system.

With a sow inclined to eat her young, it may be wise to remove the pigs from her immediately after farrowing, for a few days, except at suckling time, when she is carefully watched.

If the abnormality becomes habitual, it is wise to dispose of the sow.

MIXING PIG FOOD.

When pig food has to be mixed by hand, whether wet or dry, much labour can be saved and better results obtained by mixing in the right way. The water or swill that is used in slop-feeding must always be put first into the receptacle, be it bucket or tub, and the meal measured into it in such quantity that when all is mixed together a creamy consistency is obtained. A flat paddle is the best tool for mixing, and it should be kept quite clean. When more than one dry ingredient is used it is better to add each one separately to the slop and to stir it in well before putting in the next.

Unless each kind of food is well mixed in, the ration will not be balanced and some pigs may get too much of one ingredient and not enough of another. Particular care should be taken with highly concentrated stuff like fishmeal, which is used in a small quantity, and must therefore be very thoroughly incorporated. This can best be accomplished by putting it in first, adding the next smallest quantity of ingredient next, and keeping the largest to the last.

In mixing dry food it is better to reverse this process, the ingredient which forms the greater bulk of the mixture being first spread out thinly on an even floor. A thorough turning of the pile should be given as each ingredient is added, taking care that the shovel goes beyond the centre of the heap each time. Dry food cannot be turned too often, and one should not be satisfied until on picking up a handful one finds that it is impossible to do so without getting a proportion of each substance used without an excess of any. A flat-tined fork is a useful implement for mixing dry food, turning the heap first with this and then finishing off with the shovel.

INVESTIGATIONS ON SOME NATURAL FOREST PRODUCTS IN NEW GUINEA.

By R. E. P. Dwyer, B.Sc.Agr.

This article is concerned with a valuable phase of the activities of the Department of Agriculture, which is not generally realized in this Territory. In this connexion some recent findings concerning a few selected examples of native products are considered worthy of publication. It is conceded, however, that some of the information obtained was not encouraging from the commercial aspect.

No. 1.—*Parinari laurina* (= Kusta Nut in New Guinea and Makita in Fiji).—Sir Arthur Hill, Director of Kew, has pointed out[8] that the above name is now employed in place of *Parinarium laurinum* which was used as the botanical name of this species until quite recently. He has also supplied some valuable information concerning the economic possibilities of utilizing the fruits of this species.

Parinari (*Parinarium*) is a genus of trees belonging to the family *Rosaceae* and found in the tropics generally. There are several species of this genus in the Malay Peninsula, Netherlands Indies, South Sea Islands (including New Guinea, Papua and the British Solomons) Philippines, Fiji and North Australia. According to Burkill,[2] oil from the seeds of several African and Brazilian species is expressed.

P. glaberrimum, Hassk, found in Malaya, has an oily seed. This is also found in New Guinea according to Schumann and Lauterbach[14] also *P. arramense* has an oily seed and probably other species have too.

A species *Parinari Hahlii,* Warb, from Ponape, Caroline Islands, was examined by Professor Mannich[11] in 1902, and it was stated that "Fett ist in den nüssen nicht enhalten," i.e., "There is no fat contained in the nuts." Tannins were found to be present in the fruit.

Parinarium cormybosum Miq. (*P. Griffithianum*), Benth in Hook, is recorded by Schumann in the Flora of Kaiser Wilhelms-land,[15] as being found in Augusta Station and Lagerburg on the mainland of this Territory. He mentions its distribution in the South Seas and New Guinea and Papua, and also refers to its existence in North Australia. It is also found in Java, Borneo and the Philippine Islands. According to Whitford[18] this is one of the best timber trees of this genus. *P. Griffithianum* is present in New Ireland according to Father Peekel, but is not so common as *P. laurina.*

The *Parinarium glaberrimum* was collected from the mainland and also one of the outlying islands. There is the possibility that *Parinarium myrsinoides* described by Schlecter from New Caledonia and that *Parinarium insularum* may be found here, though they are, as far as known, not recorded.

In a recent work Hill[7] has shown "that with two exceptions in all other species of the genus, a close-fitting stopper or cork seals the orifice of the seed cavity. On germination the plugs or stoppers are forced out and ejected like corks from a bottle. Two species of *Parinari* have been noticed which do not show this stopper mechanism. *P. glaberrima Hassk.* (*P. laurina* A. Gray) from the Malayan region is one of these, it has much larger fruits than is usual in

the genus; they contain, however, only a single seed, which consists chiefly of the much convoluted, pink, fleshy cotyledons; the radicle splits the fruit open through the scar of the pedicel, but there is no pore or stopper."

It also would appear from this note that *P. glaberrima* is the new name for *P. glaberrimum* which is now regarded as a synonym of *P. laurina*.

Burkill's notes on *P. glaberrimum* are quoted (probably synonymous with *P. laurina*) almost verbatim.[2] He states that "this is a tall tree which occurs in Java, Borneo and eastwards in the Pacific, while once it has been obtained from the Malay peninsula in Perak. The timber is hard, very heavy, but not durable in contact with the ground (according to Schneider Bur. For. Philippines). Rumpf gives several uses for the kernel in Amboina. He says *inter alia* that it arrests diarrhoea; and that a paste of it is used for coating the wood of boats that have been attacked by Teredo or ship-worm."

According to Heyne,[6] Greshoff found 31 per cent. of oil in the seeds. This observation is most interesting as it means that fruits of this species would be worthy of further investigation. Attempts are necessary to get a true botanical identification of the species present in this Territory, and also to collect fruits of the species mentioned here.

On the understanding that the fruits of *Parinari laurina* contained a valuable drying oil the Director of the Imperial Institute, London, very kindly submitted specimens of fruit from New Guinea to a detailed chemical examination. The findings are given verbatim under a separate heading as supplied in a report to this Department.

The following remarks on the Kusta Nut as supplied by Sir Arthur Hill,[8] in answer to an inquiry from here indicated that the local product was at least worthy of the chemical investigation which he suggested:—

"*Parinari laurina*.—The kernels of this species have recently attracted a certain amount of attention on account of the drying oil they contain, reputed to be not unlike tung oil, and the oil has been the subject of chemical investigation in more than one quarter. It is no doubt the drying properties of the oil which render the masked kernels suitable for stopping holes in canoes and fixing spear-heads by the natives of New Guinea, as stated.

Little appears to be known regarding the potential commercial value of the seeds. In this connexion the following remarks from the Director of the Paint and Varnish Research Station at Teddington, near London, where a small sample of seeds from Fiji was recently examined, may be of interest:—

> 'With regard to the possibility of using this material within the industry, the question is probably largely one of economics. The amount available was too small to carry out any useful experiments of a practical nature on its application, but the oil was found to body up very easily, and to form a solid gel, like tung oil, but with far greater rapidity. It dried up to a hard film. If such oil were manipulated alone, it might present difficulties, which could, however, be overcome.
>
> Probably if the oil could be produced cheaply, it could be absorbed within the industry, but there is no great chance of a ready-made demand.'

In the Kew Museum collections there are seeds of this species from Fiji, where they are said to be used for scenting coco-nut oil. We are not aware that the qualities of this seed have been investigated from the perfumery standpoint."

W. D. Francis, Botanist at the Botanic Museum and Herbarium, Brisbane, identified specimens of fruits sent to him from this office, in 1935, and originally collected from New Hanover by Mossman, Inspector and Instructor at Kavieng, as *Parinarium laurinum*. Francis stated in his reply that "the natives of Fiji

obtain from the seeds, called 'Buri Nut' or 'Makita' a much esteemed perfume; they also heat the kernels up into a kind of putty which is used for stopping holes in canoes and for fixing spear heads." The kernel is used as a putty by natives in this Territory for similar purposes, but it is not, as far as known, used for preparing a perfume. In Fiji it is said that the perfume is used for scenting coco-nut oil which is used for anointing purposes. It seems that no commercial uses for this perfume are so far known.

Father Peekel, of the Catholic Mission, Ugana, New Ireland, who is also a well-known botanist, kindly supplied the following note:—

"Regarding the genus *Parinarium* I know of only two species here. The common *Parinarium* is *P. laurinum* A. Gr.; the fruit is ovoid, and one celled. The seeds are used, everywhere by the natives, to fill up the fissures of their canoes. The native names are as follows:—Katita, katite, tite, or of similar form. The second species is *P. Griffithianum Benth.* The fruit is oblong and two celled. I have a specimen of this in my herbarium, but the tree is not so common as *P. laurinum.*"

It is of interest to note that in Fiji some local varieties of Makita (*Parinari laurina*) are existent. Parham[1] records that the following types were collected in 1934, viz., "*Makita damu*", "*Makita leka*", "*makita dina*" and "*makita salusalu*". It was not stated whether these are varieties or sub-species. This varietal variation would suggest that there would be considerable variation in the production of fruits and contained oils. Such variation, combined with the greater amount of acid decomposition which occurred on the long voyage to England from New Guinea, might quite well account for the differences in oil content recorded between this and fruits from other sources. A search for varieties or sub-species of the kusta nut has not yet been made by this department in New Guinea. If at any time it is considered that the product is worth further investigation this would provide a promising line to pursue.

The kusta nut has been the subject of some inquiry from New Guinea residents. Mr. E. R. Miller, owner of Tsalui Plantation, Lavongai (New Hanover), stated that the trees grow prolifically in the vicinity. It was queried whether the nuts contained any substance of commercial value. The information was also given that Mr. Draper, of Nanianne Plantation, on one occasion forwarded some of these nuts to Brisbane, where the pulp was analysed and was reputed to contain an excellent lacquer.

Mr. J. H. L. Waterhouse kindly collected a sample of kusta nuts, for despatch to England, from a situation close to the native school at Nodup, Rabaul, and also supplied the following notes:—

"It was hoped to secure about a hundredweight of the nuts, but the commodity is much harder to procure than previously imagined. The quantity forwarded should prove enough for small experiments.

The kernel only is used—grated and applied raw to leaks or crevices in canoes after which wood ash is applied. The natives state that without the addition of the ashes the putty is not strong or effective ("ogor") which fact may be helpful in determining its uses."

It was suggested that the outer covering be investigated.

The tree is believed to be a rather shy bearer, but is fairly widely distributed in this Territory. W. A. Mossman, Departmental Inspector, found it difficult to collect fresh nuts, as they germinate quickly in the undergrowth, while the kernel is inclined to disintegrate quickly under rain forest conditions.

The Director of the Imperial Institute,[7] referring to the notes supplied by Mr. Waterhouse, stated—

"We have not investigated the possibility of using the grated kernels, as this would not be a practical issue in the United Kingdom. It is, moreover, not feasible to suggest any commercial use to which the husks of the fruits could be applied, except the possibility that they might be of use in the manufacture of industrial charcoal. This point, however, would not be worth investigation unless large quantities of fruits were available and the kernels themselves were disposed of as oilseeds."

Conclusions.

Among the factors which would militate against the commercial exploitation of the fruits are—

(*a*) the apparently very limited supplies;
(*b*) the statement that the kernels keep badly.

Parinari Laurina Fruits from New Guinea.

Results of Chemical Investigation by The Imperial Institute (31*st August*, 1936).

The sample, which is the subject of this report,[8] was forwarded to the Imperial Institute by the Assistant Director, Royal Botanic Gardens, Kew, in July, 1936, being originally received from the Department of Agriculture, Territory of New Guinea.

Description.

The sample, which weighed 3½ lb., consisted of reddish-brown, roughly oval fruits, varying in size from 2½ inches long by 1¾ inches in diameter to 3½ inches long by 2¾ inches in diameter. The fruits, as received, were composed of fibrous husk from ¼ to ½ inch thick, enclosing a kernel varying in colour from pale purple to chocolate and in consistency from fairly hard to hard. In the case of some kernels, part of the outer surface was covered with a light brown skin.

Results of Examination.

The fruits were submitted to examination with the following results:—

Table.

Fruits—	
Average weight of a fruit	76.2 grams.
Husk	52.2 per cent.
Kernel	47.8 „ „
Oil, expressed on entire fruits	5.7 „ „
Kernels—	
Average weight	36.4 grams.
Moisture	11.4 per cent.
Oil, in kernels as received	12.0 „ „
Oil, expressed on moisture-free kernels	13.6 „ „

The oil extracted from the kernels with light petroleum was a pale buff fat of soft consistency. It oxidizes very readily in the air at ordinary temperatures forming a substance which is gelatinous at 100 degrees C., and is not soluble in the unchanged oil. The oil was examined with the following results, which are shown

in comparison with those obtained by Tsujimoto and Koyanagi[17] for the fat of *Parinarium laurinum* (*Jour. Soc. Chem. Ind., Japan*, 1933, *Vol.* 36, *suppl. binding p.* 110):—

	Present Sample.	Fat of *Parinarium laurinum*.
Specific Gravity at 100° C./15.5° C.	0.9025	0.9379 (*a*)
Refractive Index at 40° C.	1.5429	1.5610 (*b*)
Melting point	37.1° C. (*c*)	49–50° C.
Acid value	33.8	1.31
Saponification value	193.7	186.8
Iodine value (Wijs, 1 hr.), per cent.	202.8	214.1
Unsaponifiable Matter, per cent.	1.2	1.15

(*a*) Density at 50° C/1° C. (*b*) At 50° C. (*c*) Open tube method.

The foregoing results show that the kernels of these *Parinari laurina* fruits contained only a very low percentage of oil. The oil belongs to the "drying" class of fatty oils. It has been shown by Tsujimoto and Koyanagi, *loc. cit.*, and Farmer and Sutherland,[3] *Journ. Chem. Soc., June*, 1935, p. 759, to contain as one of its components a highly unsaturated fatty acid, the presence of which would account for the high iodine value and high refractive index.

Remarks.

It is unlikely that it would be remunerative to offer kernels of the quality of those in this sample of fruits as a commercial oil-seed, owing to the low yield of oil which they furnished. A much higher yield of oil, viz., 44 per cent., has been recorded by Farmer and Sutherland (*loc. cit.*) for the kernels of this species (country of origin not stated). It is also improbable that the oil could be profitably produced in the Territory for shipment to the United Kingdom especially as it possesses the disadvantage of oxidizing very readily in the air at ordinary temperatures; the expression of the oil from the kernels would therefore have to be carried out under special conditions.

In addition to the low oil content of the kernels, the fact that supplies of the fruits are very limited, and that the kernels are stated not to keep well, render the prospects of commercial utilization unpromising. It is possible that the low yield of oil in the kernels examined may be due in part to deterioration if this sample has aged, and that fresh kernels might contain a higher percentage.

This species and other closely related species, some of which are found in New Guinea, have been the subject of investigations by forestry officers in other countries as a timber product. Burkill (*loc. cit.*) and Ridley[12] in Malaya and Whitford[18] in the Philippines are amongst the authors who have discussed the timber possibilities of this group.

Ridley describes *Parinarium griffithianum*, Benth, as a large tree 70 to 80 feet tall with deep green leaves and white flowers, but not very abundant in Malaya. Wood, red with light markings, grain medium, fairly hard, splits very slightly

in drying, durable, weight 49 lb. 8 oz. per cubic foot. He says that according to Van Eden, this is a good timber giving beams 5 inches to 6 inches square. Habitat usually near the sea.

Whitford (*loc. cit.*) says that this is the only tree of the *Rosaceae* of commercial importance in the Philippines, where it is known as Liusin. His comments regarding the wood are that "the sapwood is creamy white in colour; the heart-wood is light reddish brown, very hard, extremely difficult to saw, fine and usually straight grained. It is very durable in contact with salt water. Liusin is especially valuable for piling and is also used for ship-building and house-posts. Other species of the genus *Parinarium* produce wood indistinguishable from Liusin.

Burkill[2] quoted Foxworthy[4] as stating that all the Malayan species of *Parinarium* (including *P. griffithianum*), seem to furnish wood of similar quality. It is pink or reddish in colour, very hard; heavy, fairly durable, but very little used. The wood is sufficiently good to be suitable for posts especially in salt water, but it is subject to dry rot. It is not ordinarily found in large sizes. In some places the wood of various species is not used, or used only for charcoal, on account of its extreme hardness. It seems that these remarks largely apply to New Guinea forests as in most parts the distribution of trees is scattered.

Parinarium laurinum=*Parinari laurina* from the forestry point of view, was described by Lane Poole[10]. A specimen from his collection No. 810 is in the department's herbarium as collected from the Mavelo River, Papua.

A small to medium tree 3 feet in girth and 30 feet high. (One authority states that this tree may grow 30 metres high.)

Leaves.—Simple, alternate, on swollen, brown, tomentose petiole (hairy leaf stalk), ¾ inch long; blade 5 inches to 10 inches by 1½ inches to 2 inches; lanceolate somewhat oblique, acuminate, Venation prominent, stiff, glabrous and thin.

Fruit.—A very hard, rough, woody fruit, ovoid in shape when ripe 3 inches by 2 inches. When green a flattened ovoid shape. Woody shell 5-16 inch thick; inside a convoluted kernel 2 inches by 1½ inches.

Bark.—One-eighth of an inch thick, brown finely lined, inner bark reddish.

Wood.—Sap white 1 inch, heart light brown. Axes firmly.

Rays.—Very indistinct, 390-400, sinuous around if not broken by pores which cover a width of up to five rays. Indistinct on longitudinal sections. Pores—900 to 2,000 in irregularly scattered clumps; single. Soft tissue. Very fine lines link up the rays; 250 to the inch.

General.—A reddish brown wood with a dense grain. Cuts hard, weight 52 lb. per cubic foot.

Remarks.—The shell of the fruit is grated upon a stem of pandanus and the gratings are used to make caulking for canoes.

According to Schumann and Lauterbach[14] this species was first described by A. Gray[6] (in Unit. Stat. Explor. Expedit. of Bot. Wilk. Exp. Vol. 1, page 490) and it has the following distribution:—Fiji Islands, Solomon Islands, Island of Bougainville, Admiralty Islands (Manus).

The author comments that it is also moderately plentiful on the whole of the Bismarck Archipelago, and is stated to be particularly abundant on Lavongai (New Hanover) Island.

It would appear that it would not be worth while to continue these investigations until some more definite market is available for oils derived from *Parinari*. It is regrettable that there are features other than the actual oil content of the fruits, which mitigate against the use of the product for commercial purposes.

One potential use, however, is the utilization of oil-bearing species of *Parinari* for schemes of re-afforestation in the tropics, where this becomes necessary. In that case it would be necessary for a local chemist to examine each individual variety and species, until those with the highest yield, oil content and best timber possibilities are isolated.

It is intended to discuss the possibilities of exploiting some other natural forest products in future publications of the *Agricultural Gazette*.

ACKNOWLEDGMENT.

The department is greatly indebted to Sir Arthur Hill, Director, Royal Botanic Gardens, Kew, and to Sir Harry Lindsay, Director of the Imperial Institute, South Kensington, London, for their courtesy and help in carrying out these investigations on the fruits of *Parinari laurina*. The collaboration of Father G. Peekel, of Ugana, New Ireland; Mr. J. H. L. Waterhouse, of Nodup, New Britain; and of Mr. W. A. Mossman, Inspector and Instructor, stationed in New Ireland, both in collecting specimens and providing comments is gratefully acknowledged.

LITERATURE CITED.

1. Annual Bulletin of Divisional Reports, Department of Agric., Fiji, p. 56, 1934.—(Refers to collection of varieties by Parham, B.E.V.)
2. Burkill, I. H.—A Dictionary of the Economic Products of the Malay Peninsula, vol. II. (I-Z) pp. 1165-1168. Pub. Crown Agents for Colonies, London, 1935.
3. Farmer and Sutherland (quoted 8).—Journ. Chem. Society, June, 1935, p. 759.
4. Foxworth.—Philippine Jour. Sci. C.2, 1907, p. 386.
5. Gray, A.—Unit. Stat. Explor. Expedit. of Botany. Wilk. Exp., Vol. 1, p. 490.
6 Heyne, K—Nutt, Plant. Ned. Ind. ed. of 1927, pp. 696-8.
7. Hill, A. W.—Reprint Annals of Botany—New Series—Vol. No. 2, April, 1937, pp. 239-256.
8. Correspondence on *Parinari*.—From Director, Royal Bot. Gard., Kew, England.
9. Imperial Institute (Director Sir Harry Lindsay).—Results of chemical investigations, August, 1936, South Kensington, London.
10. Lane-Poole, C.E.—The Forest Resources of Papua and New Guinea, Rept. Govt. of Com. of Aust., 1925.
11. Mannich, T.—Results of Analyses of *Parinari Hahlii* for "Kolonial Wirtschaftliche Komitee". Tropenpflanzer, Jahrg VI., 1902, pp. 370-371.
12. Ridley, H. N.—Flora Malay Penins. (Polypetalae). Pub. L. Reeve and Co., Vol. I., pp 666-71, London, 1922
13. ——— Agric. Bull. Straits and F.M.S. 1, 1902, pp. 144-45.
14. Schumann, K., und Lauterbach, K—Die Flora Der Deutschen Schutzgebiete in Der Sud-see. Page 341, Leipzig, 1901.
15. Schumann, K., Hollrung, M.—Die Flora von Kais. Wilhelm Sel—Asher, Berlin, p. 93, 1889.
16. Schlecter, R.—Flora New Caledonia—Beitrage Zur Kenntnis der Flora von Neu-Kaledonien, p. 133, 1905.
17. Tsujimoto and Koyanagi (quoted 8).—Jour. Chem. Soc. Ind. Japan, 1933, Vol. 36, Supp. binding p. 110.
18. Whitford, H. N.—The Forests of the Philippines, Part 11, The Principal Forest Trees, Bull., No. 10, p. 34, 1911.

PROGRESS OF NATIVE AGRICULTURE IN THE MADANG DISTRICT.

By Colin C. Marr, Inspector and Instructor.

Introduction.

In his report,* Colonel Ainsworth pointed out the importance, in fact, the essential necessity, of the development of native agriculture as a means of raising the status of the native.

The terms of the Mandate, "to promote to the utmost the moral and material well-being of the natives", if they are to become more than a mere empty literal form, must be translated into action, and to this end the development of native agriculture as recommended by him is the first and most obvious step.

Colonel Ainsworth advocated a policy of agricultural development, under which the natives will gradually become producers, and so help to increase the exports of the country, and at the same time improve their own material well-being. (Para. 34.)

In para. 64, dealing with the Agricultural Department, he said: "I consider that the Department should be responsible for instruction and advice in connexion with the cultivation of food and other economic crops by the natives, and that such instruction form the main and, for a time, the only line of industrial education undertaken by the Administration".

In para. 181, he stated, "The Education Ordinance, *inter alia,* provides that the Administrator may establish education in agriculture, and I suggest that such education be started without delay".

Again, in para. 185, he comments: "The greatest educational force is, and will be, example and industry, and in the case of the New Guinea native that example and industry, for some years yet to come, must be tillage of the soil, which is the oldest form of industry known to man".

In view of the foregoing recommendations, the Administration, through the medium of the Department of Agriculture, has, during more recent years, re-adjusted its policy so that, at the time of writing, we find an instructional staff of officers composed almost entirely of graduates of an Australian university or agricultural college, patrolling the many districts in the Territory. Instruction is given in improved methods of agriculture, particularly with regard to rotation of crops and the necessity of cessation of such primitive methods as the disastrous "shifting agriculture", so commonly practised by all tribes throughout the Territory.

The mere introduction of new food crops for cultivation will not suffice, in the present conditions of the native population, to meet the requirements of the situation. The disinclination or apathy, too often present, must be dispelled, and under the best conditions, where the natives are eager to learn, they need instruction and tuition, and more than anything, practical demonstration.

This will in the end be overcome when cultivation is extended over wider areas and crops are grown in greater variety. At the same time the native population has to accustom itself to the new foodstuffs, to provide storage for the crops harvested, and generally to advance toward the betterment of an agricultural people.

* Report by Colonel John Ainsworth, C.M.G., C.B.E., D.S.O., on "Administrative Arrangements and Matters Affecting the Interests of Natives in the Territory of New Guinea, 1924."

At present native cultivation is practically confined to coco-nuts (*Cocos nucifera*), *taro* (*Colocasia esculentum*), yams and mammies (*Dioscorea spp.*), bananas and plantains (*Musa spp.*), sugar cane (*Saccharum officinarium* and *Saccharum robustum*); and to a lesser extent, varying with the locality, "aibika" (probably *Abelmoschus manihot*), "pit" (probably *Saccharum arundinaceum*) and papaia (*Carica papaya*). In the first instances cited the crops are all of long-term habits, that is, planting takes place one year and the crops come into bearing in the course of two, three, four or more years. The effect on village life is that one season's work in clearing and planting, with the stimulating and invigorating effect that all such industrious effort brings, is followed by several years of apathy during which little is done. To inculcate some real agricultural instinct in the native population, it is essential that they should be taught the cultivation of annual crops, where the seasonal operations of tilling the land, sowing the seed, and harvesting the crops occur regularly.

There are other crops in view for introduction and cultivation, in conjunction with accessory crops, which are necessary to counteract failure of any one crop in the schedule. Two crops are in view, namely, rice on the coastal areas, and soya-beans in the recently controlled higher-altitude hinterland.

The revenue of many countries in the world is dependent largely on the export of its native produce harvested. The corollary to a large export trade is a considerable revenue to Administration, whether derived from export tax, import duty, or head tax, and under the financial stringency existing in the Territory, this consideration is important both from the point of view of the original cost in introducing new crops, and its probable ultimate cost. The results of this policy should more than justify the original outlay.

Under the policy of native agricultural development, the natives are required to grow crops which, if the object of the policy is to be obtained, will result in the creation of a surplus of agricultural products for export.

This will apply generally throughout the Territory, but not in the Rabaul district, where the natives have, through the process of absorption, become industrialists, and are not beholden to agriculture for their livelihood to any great extent.

Crops Generally.

The shortage of grain crops—other than maize—and the native custom of subsisting almost entirely on root-crops, indicates that other cereals should be introduced into the native dietary for supplementary reasons.

Rice has been tried out in the Rabaul district with moderate success, but climatic and adverse soil conditions combined to produce rather disheartening results. Notwithstanding, however, one Paramount Luluai (or Head-man), has continued to plant annually sufficient rice to meet the needs of his family, who find no difficulty in hulling the grain with a hand pestle and mortar sufficient for their needs as required. The grain is not as full as that produced in other parts of the Territory, and it is confidently expected that further experimentation with this particular cereal will yield more encouraging results.

During Dr. Bryce's period as Director of Agriculture in this Territory, 6 tons of selected seed maize of the varieties of Hickory King and Red Hart Flint were imported from the Department of Agriculture in South Africa. The whole consignment was fumigated before despatch from South Africa, and it arrived in this

Territory in excellent condition. The seed was distributed amongst the natives through the District Office, to plantations through the Expropriation Board, and individually to missions, private planters, and natives, as requests were received. The Hickory King variety was confined to the Bismarck Archipelago, and the Red Hard Flint to the New Guinea mainland and the Solomon Islands. The results were not an unqualified success, the Red Hard Flint variety seemingly being the better of the two.

The introduction of seed into any new country with new conditions of soil and climate is always attended by some uncertainty. It can be easily followed, therefore, that the work of acclimatization and selection of suitable types assumes a position of some importance, and the necessity of continuous observation under the conditions afforded by an experimental station is demonstrated.

In view of the diversity of soils and of the variety of climate obtaining between the several districts of the Territory, it is evident that intensive experimentation is warranted in each district. To date only one experimental or demonstration plantation is in existence, and that is at Keravat, situated in the New Britain district, 30 odd miles from Rabaul; but the results obtained thereon cannot be logically assumed to be applicable elsewhere in the Territory.

The Madang district, particularly the hinterland embracing the Ramu, Wahgi and Purari valleys, which appear to hold great possibilities in both grazing and the cultivation of higher-altitude crops such as cinchona, tea, coffee, and soya-beans, is sorely in need of an experimental station close to the township of Madang and within the limits of travel to the average planter in the district.

Approximately two years ago, the Director of Agriculture recommended the establishment of a station in the Upper Ramu area for the purpose of experimentation with various tropical and sub-tropical crops. An officer of the Department of Agriculture was sent to this area, which at the time was situate in the Morobe district, and the results obtained appear to be most promising and warrantable of expansion. Since this station was established, this portion of the hinterland has been transferred to the Madang district. It is confidently expected that, with the addition of a station on the coastal area working in conjunction with the inland station, increased developmental work would result.

Rai Coast.

During the past two years the Administration, to consolidate Government influence, has posted an officer of the District Services at Saidor, on the Rai coast, south of Madang township, and about 60 miles by airline. This move was brought about in view of recent hostilities amongst inland tribes.

A suitable site was chosen as a base, centrally situated, and with good soil conditions. An airport has been constructed alongside the base, thus bringing Madang within 35 minutes by air.

Whilst on patrol in this area in the early part of this year, opportunity was taken of visiting several portions of the hinterland under the guidance of Mr. Patrol Officer Greathead, for the purpose of making a brief agricultural survey of the country.

Intense interest was shown by the natives in agricultural instruction, and the greatest co-operation afforded by the District Services representative, who expressed the keenest interest in all matters pertaining to agriculture.

All coco-nut groves, native-owned, in the district were found in a clean and orderly condition, and practically free of pests and diseases.

The common belief throughout the Territory that coco-nut palms on the Rai coast are stunted, and give a poor yield, is unfounded. Many areas of palms are as healthy as those elsewhere in the Territory, and were estimated to be yielding at the rate of 1 to 1½ tons per hectare per annum. Unfortunately, little forethought by natives has been exercised in the past in the selection of suitable sites for coco-nut areas, but it is probable that they were compelled to utilize whatever land was available close to each village site, owing to the hostile nature of their neighbours.

Generally speaking, it may be safely stated that, on the whole, the soil conditions on the Rai coast are not up to par with those of the rest of the Territory, excepting perhaps Gazelle Peninsula, the south coast of New Britain, and portions of the Wewak coast.

Whilst at Saidor Base, plans were drawn for laying out the station correctly with avenues, gardens and an orchard.

The following seed, which was sent out from the Botanical Gardens, Rabaul, and planted in bamboo pots under shade, will be transplanted out in the field when ready:—

Coffea robusta.

Cassia multijuga (avenue tree).

Thevetia neriifolia (Allamanda hedge).

Murraya exotica (hedge resembling privet).

In addition to the above, the following fruit trees were planted to establish an orchard in the district:—

Brazilian cherry.
Cherry guava.
Rambutan.
Avocada pear.
Soursop.
Mandarin.
Mango.
Root cuttings of seedless breadfruit.

The soil conditions at Saidor Base, being of a deep, well-drained alluvium, are excellent. Amongst a quantity of vegetables recently received from this station was a pumpkin weighing 56 lb., whilst a bag of maize resembling Manning Silvermine (cross between Iowa Silvermine and Manning or Macleay White) equalled any seen in Australia.

A quantity of vegetable seeds obtained from a well-known Australian nurseryman was decently distributed in the district, particularly amongst the hill tribes of the Rai coast and hinterland.

The seeds introduced include—

Lettuce (Mignonette).
Cabbage (Enkhuizen Glory; Succession; Earliball).
Kohl Rabi (Early Purple).
Tomato (Burwood Prize; Bonny Best).

Potatoes, eschallots and carrots, previously introduced to the higher levels on the Rai coast, have shown remarkable adaptability, and will eventually merge into the native dietary system.

Agriculture—General.

The following is a report on the agricultural activities in the Madang district for the period 1st July, 1936, to 30th June, 1937.

Rainfall.—The average rainfall over 20 years is 136.26 inches. During the period, the total rainfall registered at the Meteorological Station, Madang, was 154.02 inches, the heaviest falls being recorded in February, November. and December.

Plantations.—Copra is the basic primary product of the Madang district, although extensive additions to existing cocoa areas have taken place over the last twelve months.

The total area under cultivation in the district is 12,608 hectares, but several applications for land have been received in respect of the Rai coast sub-district, and it is expected that, during the ensuing year, extensive developmental work will result.

The planting of coco-nuts and cacao by one planter on Kar-kar Island was carried out on a fairly large scale, whilst another plantation was commenced on Baga-bag Island.

The Agricultural Inspector and Instructor was able to visit most plantations, and it is expected that more frequent visits will be paid in the near future.

Stock.—No serious diseases were reported, and apart from a minimum of tick on cattle, and swamp-cancers on horses, general good health throughout the district is noted.

Rattan Cane.—Samples of rattan-cane from the mainland and Kar-kar and adjacent islands were despatched to the Director of Agriculture for tests of resiliency and comparison with rattans from other countries, with a view to the future marketing of this commodity.

Derris Root.—Several bales of this medicinal insectifuge in raw root stage of various lengths were forwarded to the Director of Agriculture, for rotenone content comparison with similar root of other countries, with a view to the possible marketing of this product.

Coco-nut Groves.—Extensions to grove areas on the Rai coast have been reported by the field staff. This revival of interest in an industry of primary importance to the Territory as a whole is pleasing, and can be attributed to—

(1) the recent improved prices in copra; and
(2) the sudden activity in the Rabaul district during the past twelve months, whereby natives have been encouraged by the Administration to prepare and market their own copra.

Natives who have completed their contracts of service with employers in Rabaul, on returning to their villages on the Rai coast, are now settling down, and with the above in view are preparing large areas of land preparatory to planting up coco-nuts. Where medium-sized groves already exist, driers are being erected, and copra will be produced in the near future.

Every assistance and encouragement is being given by the Administration, and arrangements will be made for the marketing of this produce on their behalf, as the Rai coast is rather isolated with no trading facilities available.

Unusual interest and activity has been shown by the Paramount Luluai of Kar-kar Island in extending the grove area of his village from 20 hectares to approximately 90 hectares, within the last twelve months. Every assistance has been accorded by the manager of the adjoining Kululi Plantation, and in addition to coco-nuts, a small area of cacao has been established under his guidance and supervision. Other than this area no further plantings are recorded on the island.

The Agricultural Officer of the district completed a patrol of the Rai coast area, extending some 60 miles over the Madang-Morobe border, and in addition to the inspection of plantations, advice was accorded natives regarding the control of pests and diseases affecting their coco-nut groves and native foods.

Manam Island.—Owing to the severe nature of the eruption occurring on this island in October and November, 1936, the annual tobacco crop—on which the inhabitants rely for revenue—was so severely damaged as to be of no commercial value whatever.

Extensive damage also resulted from falling ash and grit (scoria), on to the leaves of food crops such as taro, bananas, &c., whilst similar crops situated at higher levels near the rim of the crater were rendered useless through scorching. The peppering, however, merely delayed the maturity of the crops, but, being later than customary, trading with the mainland natives was lost.

Saidor Base.—The grounds flanking this new Administration emergency airport have been systematically laid out with lawns and suitable avenue trees introduced from the Botanical Gardens, Rabaul, and a small orchard of tropical fruit trees is now being established.

On the maturity of these trees, seed or cuttings will be available for distribution to the local planters and native populace in the area.

Bogia Base.—Should an officer of the District Services be stationed in this area, it is intended that similar agricultural activity will eventuate as at Saidor Base.

Madang Township.—Further avenue planting in the township was conducted with a flowering tree, botanically known as *Peltophorum ferrugineum.* Varieties of tropical fruit trees were planted in the grounds of several Administration bungalows.

Native Foods.—The staple food of the Madang district natives at the present time is taro and yam, the only exception occurring in the Lower Ramu valley, where sago palm (sac sac) forms the bulk dietary.

Except on Manam Island, no food shortage occurred in the district.

Sweet corn can almost be regarded as a staple food, as it is to be seen in nearly every native garden, growing between taro, yam, mammies, aibeka, bananas, pit and sugar cane.

Irish potatoes, carrots, parsnips, eschallots, cabbages, parsley, lettuce, kohl rabi, tomatoes and radishes have been introduced to many villages above 2,000 feet altitude, and have taken well amongst the natives.

It is hoped that before long Madang township will be supplied regularly with vegetables.

Root cuttings of a seedless type of breadfruit tree (*Artocarpus spp.*) have recently been introduced to the district through the Department of Agriculture, and have been distributed amongst the natives.

A quantity of fruit trees, including Avocada pear, rambutan, mandarin, lime, sour-sop and custard apple has also been sent to higher inland villages.

DERRIS FOR DOG TICKS.

When derris powder is applied to ticks already attached to a dog the ticks do not immediately die, but on the following day they will all be dead and dried up. After applying the powder to the dog ticks may get on it and re-attach quite soon, but if they get on the dog within three days after the powder has been applied they will die without engorging. To make a derris powder wash, add one heaped tablespoon of the powder to one gallon of water in which one tablespoon of soap flakes has been dissolved. Mix thoroughly. After washing, the dog should be exercised to drain off the surplus fluid, or this may be taken off by drying roughly. The wash, like the powder, does not kill ticks instantaneously or prevent others attaching, but will kill the latter for three days after bathing.

PAPAWS (OR PAPAYAS.)

(CARICA PAPAYA.)

By G. H. Murray, Director of Agriculture.

A fruit common to the Territory, but not appreciatetd as it should be, is the papaw or papaya, known botanically as *Carica papaya*. Indigenous to the West Indies and Central America, it has spread throughout the tropics and is now wild in the bush of this Territory, the seed apparently having been distributed by birds. Although growing to a height of 15 to even 30 feet, it is hardly worthy of being called a tree, and might more correctly be described as a tall herbaceous plant, and is dioecious in habit, i.e., having male and female blossom on different plants. It is of rapid growth, ripe fruit being borne in slightly less than twelve months. The plant is at its best from its first to third or fifth year, though it will frequently bear for several years, but the fruit usually deteriorates in quality with increasing age. It bears no lateral branches, but frequently forms divided erect stems. A "self-sown" plant alongside the offices of the Department of Agriculture, which has received no attention, is about 30 feet in height, has divided stems and has been bearing a large crop of fruit for at least a couple of years.

The fruit is somewhat variable in form, being commonly spherical or round. A few years ago, at the Demonstration Plantation, Keravat, there was a well-flavoured variety, weighing about 6 to 7 lb. each and obscurely angled, like some forms of rock or musk melons, but it deteriorated in quality with age. There are also elongated forms up to about 20 inches in length, and weighing as much as 20 lb., hence the fruit is sometimes known as "tree melon". The inside cavity of the fruit is usually filled with wrinkled seeds about the size and shape of pepper corns and when soft and green have a peppery flavour which is not unpleasant to some palates. There is also an almost seedless form which is generally considered to have the finest flavour and it is certainly the pleasantest to prepare for the table.

A form recently introduced to the Demonstration Plantation, Keravat, from Hawaii, is round and small, sufficient for one or two persons, well flavoured and is considered better for table use than the large size. The latter, however, would, no doubt, be more suitable for issue as pig feed, and even to native labourers, whose palates may not be quite so sensitive as those of Europeans.

The fruit can be put to many uses, although principally favoured as a breakfast dish. As a crystallised fruit it is good, but without a very distinctive flavour. It can be used in a salad sliced with lettuce, boiled green in the same manner as summer squash. It can also be used for pickles, preserves of different kinds, jellies and pies. As a jam, prepared with some Davidsonia plums (a wild, acid, purple coloured fruit in North Queensland scrubs) in place of lemons, it is particularly attractive in appearance and flavour, and I have no doubt any ingenious housewife could find other equally attractive methods for its preparation.

The plant has digestive properties, long recognized in the tropics, where it is a common practice to rub the juice over tough meat to make it tender, and old fowls are frequently wrapped in *papaya* leaves, bruised, if I remember rightly, and allowed to remain overnight before cooking.

The fruit also contains a milky juice known, when dried, as papain, which has pronounced digestive properties, having the same use as animal pepsin. This juice is collected by making longitudinal incisions in the fruit and collecting it in non-metal vessels. The hands of the collectors should also be protected and absolute cleanliness is essential. It is customary to have a small quantity of water in the vessel into which the milky juice or latex is collected. As the liquid falls into the water it coagulates and is dried on trays, formed of muslin or calico, stretched on light wooden frames. The production of papain is a minor industry, conducted mainly by peasants in some West Indian islands, Ceylon and Philippines, and can hardly be recommended for planters in this Territory, except for their wives and daughters who should find it an occupation combining pleasure with profit.

It is a plant, however, that should receive greater attention by planters in this Territory, not only for their own use, but as food for their labourers and pigs. It is also a particularly suitable plant for growing in a fowl run, as it provides sufficient shade for the birds, besides, of course, yielding good crops of fruit. It is one of the plants that could be planted between rows of young coco-nuts, with other subsistence crops. Though requiring little attention when once established, and its cultivation is easy, seedlings of the better types require attention in their earliest stage. Seeds should be sown in well prepared nursery beds or seed flats, and will germinate in two to six weeks, according to freshness of seeds and climatic conditions. When 7 or 8 inches high they should be transplanted 10 feet apart each way and shaded until established in their new position. If the weather is showery, there should be no losses, but to avoid any risks, the leaves, except those at the top of the plant, may be snipped off without removing the stems.

Papaya Recipes.

Papaya Cocktail.

Cut papaya in dice and serve in glasses with cocktail sauce and chipped ice. Or serve with orange, lemon, or lime juice, and little sugar in same manner.

Papaya Salad No. 1.

On a strip of peeled papaya lay small bits of pomelo and orange. Serve with mayonnaise on separate plates, and garnish.

Papaya Salad No. 2.

Cut papaya in cubes and add eight small onions and five pieces green celery chopped fine. Serve with boiled dressing.

Papaya Whip.

To 1½ cups papaya pulp add juice of 1 lemon, ½ cup sugar, and beat into 2 stiffly whipped whites of eggs.

Papaya Pickle.

Make a syrup of 1 measure sugar and ½ measure vinegar. Add a few whole cloves and peppercorns and 2 measures of half-ripe papaya cut into small pieces. Boil until tender.

Orange and Papaya Marmalade.

To 1 measure papaya allow ½ measure oranges. Wash oranges well. Squeeze out seeds and juice. Put skins through a meat chopper and add to the juice, strained free of seeds. Add papaya pulp cut in small pieces (without rind) and boil all together; then add as much sugar as pulp. Boil again for 15 to 20 minutes.

Papaya—Flavoured Gelatine Dessert.

½ box gelatine.
½ cup cold water.
juice 1 lemon.
1 cup boiling water.
1 cup papaya pulp.
½ cup sugar.

Soak gelatine in cold water five minutes. Dissolve the sugar in the boiling water; add the gelatine and strain. When cool, add the papaya and lemon juice. Place on ice to harden.

Papaya and Ginger.

Make a syrup of 1 measure sugar, ½ measure water, some finely sliced dried ginger, and a few slices of lemon. Add 2 measures half-ripe papaya sliced lengthwise, which has been previously simmered in water until clear but not broken.

Papaya Pie.

2 eggs.
1 cup papaya pulp.
½ cup butter.
1 cup sugar.
juice ½ lemon.

Make a bottom pie crust and bake. Cream butter and sugar. Add beaten eggs, lemon juice, and papaya. Pour into pie crust and bake. Make a meringue of whites of eggs and 2 tablespoonsful sugar. Place on pie and brown in oven.

Papaya Sherbet.

Mix 4 cups papaya pulp with 2 cups sugar and juice of 2 lemons and freeze.

Stewed Papaya No. 1.

2 cups diced papaya.
½ cup sugar.
¼ cup water.
Juice of 2 lemons.

Cut papaya in dice and stew with sugar, water and lemon juice ½ hour. Serve in sherbet glasses as a first course for luncheon or a dessert. Can use 4 oranges in place of lemons.

Stewed Papaya No. 2.

Cook in the same manner as No. 1 with ½ cup sugar and only enough water to keep from burning. Serve as vegetable.

Baked Papaya.

Cut papaya in halves lengthwise. Add a little sugar and orange, lime, or lemon juice, or a little cinnamon in place of the juice. Bake 30 minutes and serve immediately on taking from the oven. This is a vegetable.

THE VEGETATIVE PROPAGATION OF CACAO.*

By E. E. Cheesman, Imperial College of Tropical Agriculture, Trinidad, British West Indies.

It is noteworthy that all the investigators contributing to the perfection of the budding technique in different countries were inspired by the advantages to be derived from the cultivation of uniform types of cacao, in place of the heterogeneous seedling populations which are still the rule. Some mentioned earlier bearing as an additional point in favour of budded trees, but all stressed uniformity, and especially uniformity of high yielding power, as the great desideratum.

In quest of uniformity all attempted, quite rightly, to adapt to cacao, horticultural methods long established for temperate orchard crops; but in quite recent years temperate orchard practice in this respect has again moved ahead. Researches, in which the East Malling Station has taken a leading part, have shown that uniformity of yield and of other characters in temperate fruit trees depends on uniformity of rootstock as well as uniformity of scion. There is no reason *a priori* to suppose that these findings will not apply to cacao, but rather the reverse.

For this reason, when in 1930 a Cacao Research Scheme was launched at the Imperial College of Tropical Agriculture, it was felt necessary to approach the problems of vegetative propagation from a new angle. There were many problems relating to budding still awaiting solution, but it was decided to concentrate attention, so far as the propagation side of the programme was concerned, on efforts to raise cacao trees vegetatively *on their own roots.*

The numerous problems of stock-scion interactions could the more profitably be deferred for later attack because in the absence of clonal rootstocks the most promising instrument for their solution was not yet available. A summary of the results achieved and of the present outlook is the object of this paper, but, in order to explain the terminology which must be employed, a brief description of the mode of branching of the cacao tree must be given first.

Branching of the Cacao Tree.

A young cacao seedling growing healthily produces a single vertical unbranched stem, on which the leaves are arranged in a $\frac{3}{8}$ spiral, and which later forms the main trunk of the tree. After a variable time, and presumably when it has attained a certain physiological condition not yet defined, the terminal bud divides into three, four, or five, which grow out into oblique or almost horizontal branches (Fig. 1). The whorl of branches so formed is known as the fan or by the Trinidad term jorquette (pronounced horkette), the latter name being preferable, because the word fan or fan-branch can then be used for the individual limbs of the jorquette without danger of confusion. The fan branches have their leaves in two ranks, and bear secondary branches of higher orders, all with leaves in two ranks.

* Extracted from *Journal of the Imperial College of Tropical Agriculture*—Trinidad.

At a later stage a vertical branch arises from the main trunk just below the jorquette. Since it arises on old wood, there is difficulty in determining its exact origin, but it is probably axillary. This branch is known as a chupon; it has its leaves in a spiral, and it repeats exactly the behaviour of the seedling axis, growing up through the jorquette and in due course branching into a second jorquette some feet higher. A third and fourth tier may be added to the tree in the same way. The arrangement is often obscured in old trees by loss of the lower branches by reduction of the vertical part of one "storey" so that two jorquettes arise from almost the same point, or in other ways, but it can usually be traced on careful examination.

As the tree grows older, it nearly always produces from the base of the trunk, at or near ground level, additional chupons (also referred to as "suckers", "water-shoots", or "gormandizers") and if left untended may develop into a clump. In cultivation these basal chupons are most commonly cut out, though some planters like to leave two or three. If the original tree is showing signs of disease or senility, it is usual to allow a strong chupon to grow, and when it is in a condition to replace the old trunk to cut out the latter instead. For this reason "age" in cacao fields is a complex subject, since an old tree, said to be of a certain age, may have been renewed (so far as the parts above ground are concerned, and probably in roots as well) several times since the actual planting.

Normally chupons do not branch, except when they make their jorquettes but they may be induced to do so by bending them over or cutting them back, and when the axillary buds are thus stimulated into growth they give rise in every case to branches of the same type, i.e., to chupons. Fan branches on the other hand branch freely, and their axillary buds likewise normally produce shoots like themselves, i.e., fan branches of the second or higher orders. If, however, fan branches are cut hard back they will sometimes produce chupons behind the cut. Moreover, it is by no means uncommon in the field to find chupons arising from fans, and although the physiological equivalent of pruning, in the shape of a wound or canker, can often be found as the cause, such is not invariably the case.

The so-called "dimorphism" of cacao branches is thus clearly marked, yet by no means absolute and there seems to be a certain plasticity of behaviour in both kinds of buds. Buds on fan branches (fan buds) especially seem able to give rise to either fans or chupons, according to their physiological state, and shoots may be found on fan branches having a spiral phyllotaxis below and a two-ranked arrangement above. Axillary buds on chupons are less plastic, but physiological factors must certainly determine the height at which the terminal chupon bud produces its jorquette, since that height varies without any apparent morphological or genetic reason.

The practical importance of the dimorphism in propagation lies in the fact that the entire habit of the vegetative progeny depends on the type of branch or bud used. Thus in the early grafting experiments, fan branches were inarched on seedlings held in bamboo pots near the tree, and Jones describes his grafted plants as branching a few inches above the point of union and forming bushy specimens. In the budding method described as used in Jamaica and Haiti, trees were pruned to provide vigorous chupons for budwood and the result was that the budded progeny developed a main trunk. The same applies to Stahel's technique, in which chupon buds are recommended as preferable. In Trinidad,

however, fan buds have usually been employed, and as a result budded plants can be recognized at a glance by their lack of trunk, and by their spreading two-ranked branches, which need some training to make a symmetrical tree. It is to be noted that whereas there is always an abundance of fan material available on a healthy tree, there is very often under plantation conditions, little or no chupon material to be had without recourse to manipulation. Exactly the same considerations apply in propagation of scions on their own roots.

Propagation by Cuttings.

The rooting of cacao cuttings has possibly been achieved, though unrecorded, many times in different countries, but it has never previously attracted attention as an important contribution to the technique of crop improvement. Since the end of 1930, however, a systematic survey of the possibilities of the method has been made by E. E. Pyke, working in these laboratories, and the conclusions here given are based entirely on his researches. Detailed accounts have appeared elsewhere and only a summary will be attempted.

The work began with a general survey of all possible means of vegetative propagation, excluding budding and grafting. This included trials with hardwood and softwood stem-cuttings and root-cuttings, and soon demonstrated beyond doubt that between those the greatest hope of success lay in the use of softwood. By "softwood" is meant shoots that are mature but which still retain their leaves, and which are set to generate a root-system without removal or loss of those leaves; in actual texture such shoots are semi-hardwood. The success with this kind of cutting was of such an order that there appeared to be no possible economic advantage in pursuing investigations with hardwood, and subsequent work was devoted to standardization of method.

The second year's work established several principles. In the first place it showed an important connexion between the physiological condition of a tree and the behaviour of cuttings taken from it. Old trees and trees grown without shade are alike unsuitable for supplying cuttings. The general appearance of shoots likely to root well is now known, but much physiological research remains to be done before the constitutional features of such material can be defined. In the second place comparisons were made between chupon cuttings and fan cuttings, which showed little difference in ability to root, but marked differences in the type of rooting and subsequent growth. In both, the roots push horizontally, through the cortical tissues just above the callus but whereas in fan cuttings they continue to grow almost horizontally for some centimetres, in chupon cuttings they usually turn vertically down as soon as they emerge from the stem. In fans, the terminal bud, if present, usually grows out, together with several lateral buds, sometimes low on the stem, and the shoots tend to spread obliquely. In chupons, on the other hand, either the terminal bud, or in its absence a single lateral near the top of the cutting, grows out into a vertical leading shoot. The differences are illustrated by Fig. 2. The chupons, as might be expected, approximate more closely to seedlings in their behaviour, and the importance of that fact will be indicated later.

The essence of success with softwood cuttings lies, as every horticulturist knows, in keeping the leaves on until roots are formed, and to that end careful control must be exercised over both the water-content of the rooting medium and

the humidity of the air above. Illumination is also important, since much of the carbohydrate used in root-formation is presumably manufactured by the cuttings after they are set in the propagator. Temperature under Trinidad conditions needs no elaborate control, and none was attempted, since the object of the researches was less to discover academically optimum conditions than to establish the simplest technique consistent with practical results.

Full details of the propagating frames used and of the environmental factors studied are given by Pyke (loc. cit.). In average batches of cuttings, 50 per cent. root within three weeks, and good batches finally show 90 per cent. or more of successes. These figures justify the claim that a practicable technique has in fact been found. Subsequent treatment needs care if the rooted cuttings are to be successfully established in the field, but presents no very great difficulties.

Propagation by Layering.

Stooling and layering were tried simultaneously with the experiments on cuttings, and with equal success.

Aerial layering, or marcotting, in which ringbarked branches are surrounded by a ball of moist soil in sacking, has been found possible with cacao in Trinidad, Ceylon and Java, and is illustrated by van Hall (loc. cit). It is, however, a tedious method and for large-scale work possesses no apparent advantages over the setting of cuttings.

Pyke obtained excellent results by pegging down seedlings about 18 months old in the surface of the soil. Basal chupons of older trees, if they occur in a suitable position and are at the right stage, can be treated similarly. Under such treatment several of the axillary buds push out into vigorous chupon branches, and if they are then moulded up with soil they develop in a few months a strong root-system with one or more main roots running vertically down like tap-roots. Earthing-up must be deferred until the buds have made some growth, because cacao buds apparently will not burst when covered, and all attempts with covered layers failed. Secondary layers were at a later date made from the first with equal or even greater ease.

The observations are still incomplete in the sense that established cuttings have not yet been layered, that step being on this year's programme, but there appears no reason why chupon cuttings at least should not behave exactly like seedlings in this respect. Fan branches similarly laid down have so far given rise to fan-type layers, and fan cuttings may be expected to do the same. It is in layering of fans, however, that the plasticity of the buds assumes importance. It is most probable that by cutting hard back after rooting, or by some other manipulation, chupons can be induced on fan layers. Work is at present being directed towards finding the appropriate treatment for converting fans into chupons with certainty.

The possible advantages of layering lie chiefly in the ease of the process, and the fact that constant daily attention is not required by a layer-bed, as it is by a propagating frame set with cuttings. On this account the layering technique may prove more adaptable to estate routine and provides a means for the planter to bulk up an approved clone from rooted cuttings initially supplied by an experimental station. The possible disadvantages are the length of time required for rooting and the rather large space taken up by a layer nursery as compared

with a seedling nursery. Much remains to be discovered about the minimum time in which layers can be induced to root, and also about the number of rooted branches which can be obtained per unit length of stem laid down. Until these points are determined the method can neither be recommended for commercial use, nor accurately compared with the cutting technique in efficiency and practicability. Still, from the point of view of practical nursery multiplication, the outlook is the more promising for the existence of these alternative methods.

Stooling by a method similar to that used for Malling apple stocks has been tried, but so far has given results inferior to those from layering, chiefly because the shoots seem to need ring-barking to induce deep rooting, and the extra handling involved has no compensating advantage. It remains to be seen whether older stools will behave differently, and no final pronouncement on the relative merits of the two methods is yet possible.

Established Potentialities.

With the striking of cuttings and rooting of layers added to the previously established method of budding, there is now at the disposal of the research worker an almost complete range of possibilities of producing any kind of tree he chooses. A tree selected in the field by the plantbreeder as worth clonal multiplication may be grafted or budded on a seedling stock, or cuttings or layers may be taken from either its fan branches or its chupons, according to the circumstances, the facilities and the type of material most readily available on the tree. Once established in the experiment station, any type of tree can be converted into almost any other. Grafts or buddings can be subsequently layered or used as a source of cutting. Chupon-type plants will always produce sooner or later a jorquette of fan branches. The only gap in the chain is the absence of a sure method for obtaining chupons at will on fan-type plants, and it has been shown that this problem does not seem by any means insoluble. In short, isolation of any desired clone *on its own roots* becomes a matter of routine, and the main question next for solution is, which of the several methods of propagation available can be most advantageously adapted to the raising of planting material on a commercial scale. This question, however, involves at least three subsidiary ones of the greatest importance, which must be shortly discussed.

Outstanding Problems.

Ruling out grafting, which by the consensus of opinion of previous workers is less convenient than budding if seedling stocks are to be used, and ignoring any possible differences between cuttings and layers as means of propagating clones on their own roots, there are still six distinct kinds of vegetatively propagated cacao trees which now need careful study and comparison. They are illustrated diagrammatically in Fig. 3, which represents, from left to right:

Type IA, fan bud on seedling stock; IB, chupon bud on seedling stock.
Type IIA, fan bud on clonal stock; IIB, chupon bud on clonal stock.
Type IIIA, fan layer; IIIB, chupon layer.

The three major questions to be answered, in order of importance and urgency, are; (i) Should the root-system be of seedling or of vegetative origin? (Type I versus Types II and III) (ii) Should the root-system and the scion

be of different genotype or identical? (Types I and II versus Type III.) (iii) Should the scion be of fan or chupon origin? (Sub-type A versus sub-type B throughout). Only experiment can provide the answers, and it may well provide different answers under different sets of conditions. There are, however, a number of considerations bearing on each of the questions which must be reviewed even at the present stage, because they indicate the relative magnitudes of the issues involved.

(1) Root-systems.

The drawbacks of seedling stocks for temperate fruit trees are too well known to need more than mention. They arise from the fact that the parent trees from which the seedlings are raised are heterozygous, so that the seedlings themselves vary in constitution one from another, and the composite trees of which they form part after grafting or budding must likewise vary. The variations in yield and in other physiological behaviour of uniform scions when united with such variable stocks are of great economic significance, and it has come to be realized that if orchard material is to be truly standardized, stocks raised vegetatively must be used.

Similar drawbacks of seedling stocks for cacao are at present only assumed by analogy. Seedling cacao stocks are indubitably heterogeneous, and the argument by analogy is justifiable as a working hypothesis until disproved. A direct demonstration is difficult, first because there is so little budded cacao of which records have been kept, and secondly because there have until now been no clonal stocks to serve as standards of comparison. What little direct evidence there is does not contradict the hypothesis. Still, the direct demonstration must be provided before further work can be well and truly founded on a scientific basis.

On the other side of the account, there is a strong prejudice in many quarters in the tropics against trees on non-seedling root-systems. It is said that the absence of a tap-root makes them liable to fall in wind and otherwise militates against their efficiency. Such an argument must be respected and put to experimental test. That it may be true, yet only half true, is shown by Fig. 2, illustrating the essential differences which may arise among vegetatively induced root-systems themselves. At the present it seems likely that cacao stocks raised from fan cuttings or fan layers might be genuinely open to objection, whilst those raised from chupon cuttings or chupon layers might not. Steps are being taken immediately to compare both types very carefully with seedlings, but it must inevitably be some years before conclusive results can be obtained, and meanwhile other investigations must be pushed ahead on the presumption of an answer favorable to clonal stocks.

(2) Composition of Tree.

Assuming for the purposes of argument that vegetative stocks can be proven better than seedlings, the question at once arises whether budding remains any longer necessary or desirable. Budding of selected scions on selected clonal stocks would be directly analogous to the most advanced practice in temperate fruit culture, but it need not necessarily prove ideal for cacao, and this is a case where argument from analogy can easily be carried too far.

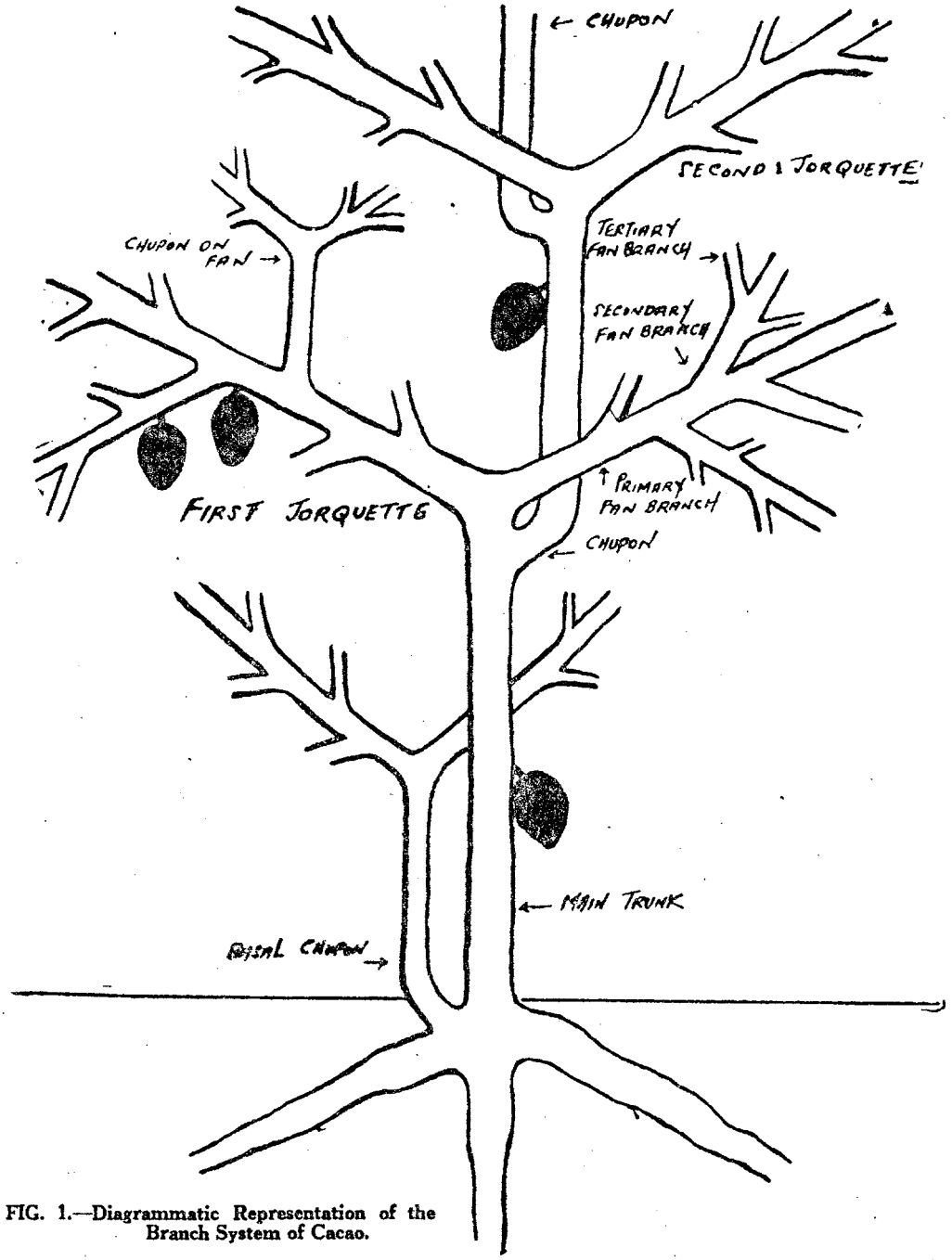

FIG. 1.—Diagrammatic Representation of the Branch System of Cacao.

Cacao trees selected for propagation will usually be selected primarily for high-yielding power, and only secondarily for qualitative characters of the fruit. In this respect they are not quite comparable with fruit varieties, which have probably in most cases been selected primarily for non-yield characters such as

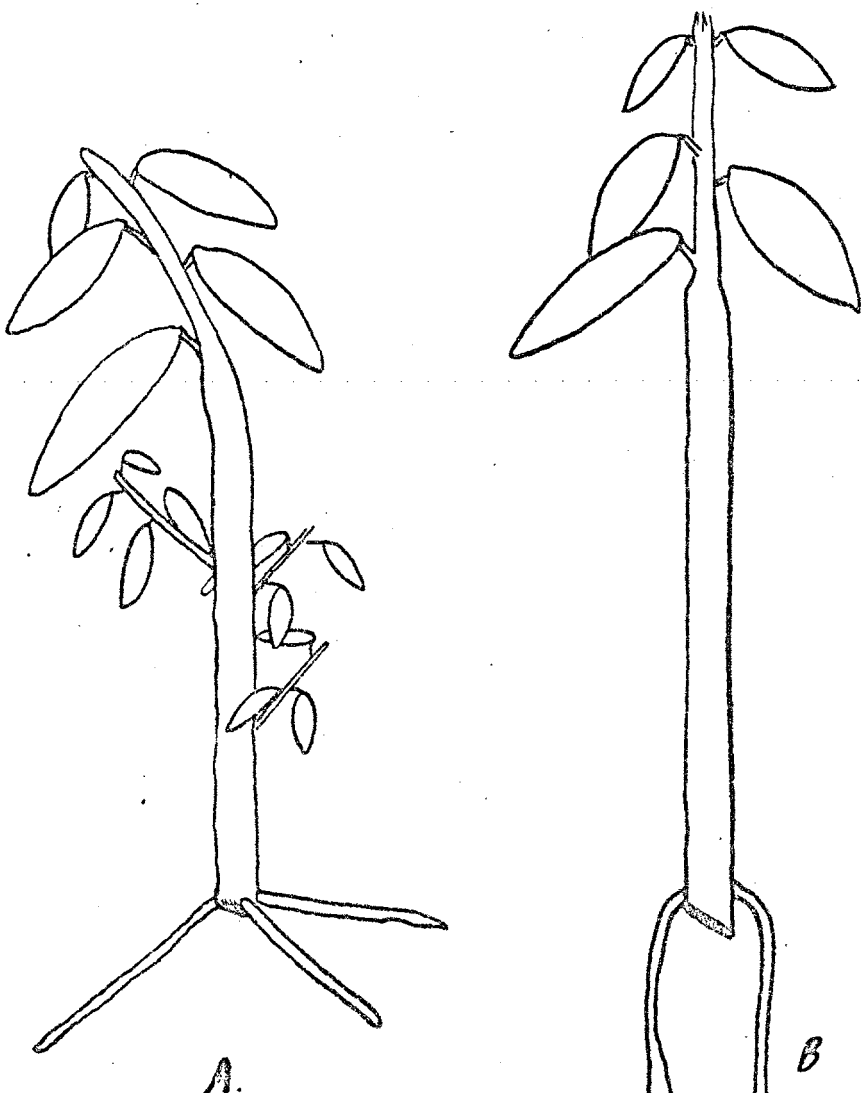

FIG 2.—A—Typical Fan Cutting.
B—Typical Chupon Cutting. (New growth only shown; old leaves omitted for simplification of diagram.)

flavour, texture, or size of the individual fruit, and only secondarily for yield per tree. The high-yielding cacao tree must have a root-system capable of supporting its yield; and if cuttings or layers from it regenerate a root-system of similar type, the main object of vegetative propagation will be attained.

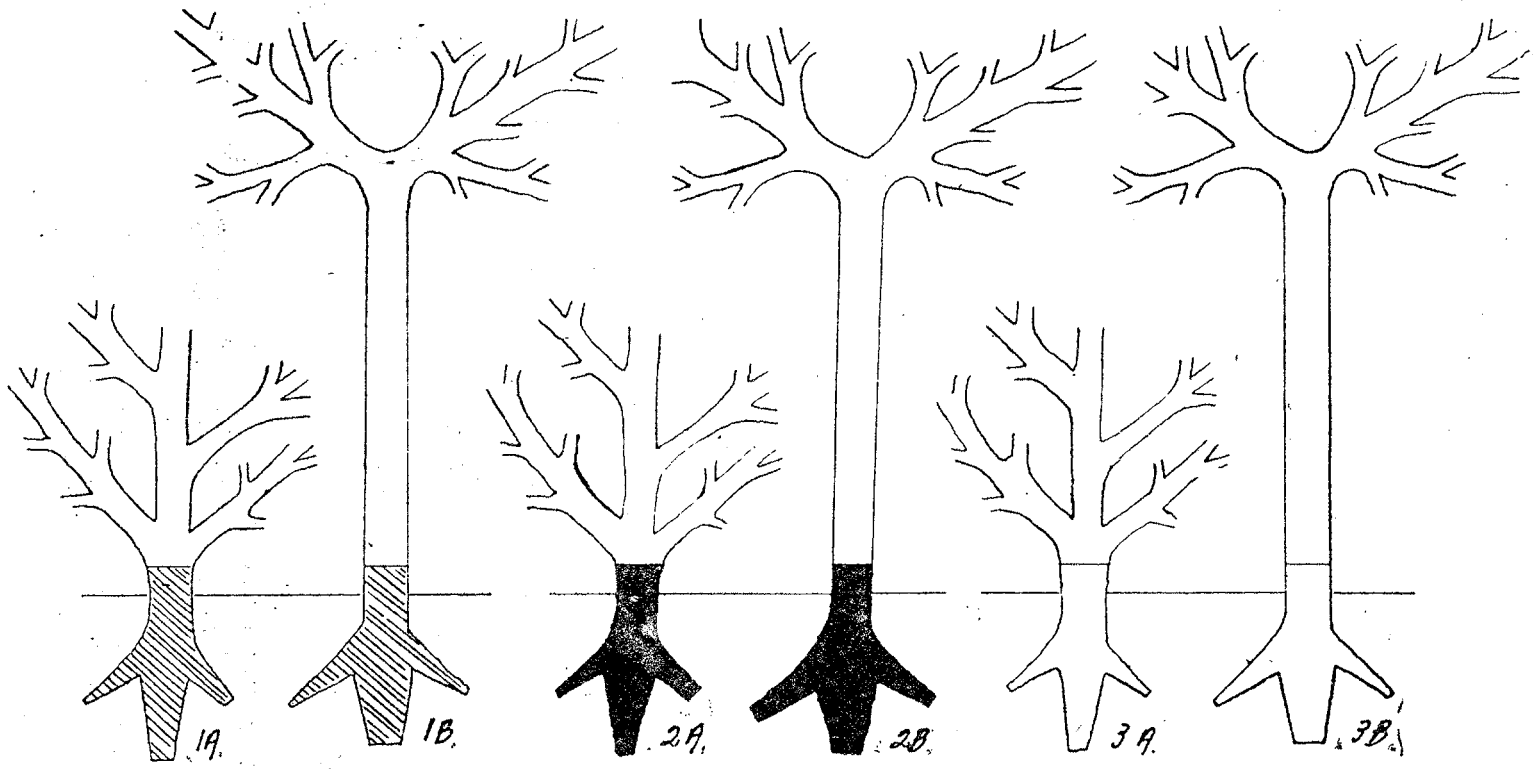

FIG. 3.—Types of vegetatively propagated Cacao trees:
1. Budded on seedling stock. A. Fan bud. B. Chupon trees.
2. Budded on clonal stock. A. Fan bud. B. Chupon bud.
3. Unworked. A. Fan cutting or layer. B. Chupon cutting or layer.

It is not overlooked that a scion good on its own root-system might give even better results than its parent if placed on another; neither have the possible uses of different stocks to change the habit of the scion been forgotten. Dwarfing stocks, for example, might be very valuable for "filler" trees in laying out new plantations at a wider spacing of the "permanent" trees. There is, indeed, scarcely any limit to the amount of research which will be needed into the interaction of stocks and scions in cacao culture, now that clonal stocks are available for accurate studies.

At the same time there is a factor of quite another kind which cannot be excluded from this part of the discussion, and that is disease. Canker (caused by *Phytophthora Faberi* Maublanc) is one of the most destructive of diseases of cacao, and causes incalculable losses. It is one of the advantages of the seedling cacao tree that, should the main trunk or jorquette be badly attacked, the whole system can be regenerated by allowing a basal chupon to grow, and it has been pointed out above that this practice is regularly followed. A budded tree naturally cannot be regenerated in similar fashion, because if a basal chupon grows it is of the stock and not the scion variety. A tree from a layer, however, will behave in this respect like a seedling. The natural regenerative power of the cacao tree is a valuable economic asset not shared to the same extent by the majority of species usually budded or grafted, and may possibly prove the deciding factor between "foreign" and "self" root-systems, at least in many districts where canker is especially rife.

(3) Branch-systems.

It has already been hinted that if layers (Type III) should ultimately prove the most satisfactory means of propagation, as on the balance of available evidence seems not unlikely, the choice between fan and chupon material for multiplication is likely to be decided by the nature of the respective root-systems. If, however, trees of Type I or Type II prove preferable, the question of branch-systems will add itself to the more urgent ones already discussed.

On account of the cauliflorous habit of cacao, if a main trunk is required on a budded tree it must be obtained from a chupon bud set low on the stock. The alternative method of budding high with a fan bud and allowing the stock to form the trunk is impracticable, because the stock would then bear fruit, and the crop would be only partly derived from the scion variety. Consequently, the choice of bud seems to be essentially a choice between presence or absence of a main trunk, and this would appear to depend more upon the tastes of the planter and the kind of cultivation he intends to give the trees than upon fundamental botanical considerations. Sub-types Ia and Ib are already both grown on a small scale with success, and whilst there is undoubtedly scope for experiments to compare the two, the problem seems both less urgent and less difficult than either of the two foregoing.

INSECTS THAT RIVAL MAN.

By A. W. Haslett (Reprint John O' London's Weekly, 20/8/37.)

Somewhere about three-quarters of a million kinds of insects are known to science. They are also more numerous than all other animals put together, so that it has been said, and with good reason, that they are really a dominant type of life on earth at the present time. We can claim, it is true, that we can protect ourselves against the more noxious varieties and make commercial use of others—for example, the honey bee and the silkworm. But the degree of protection achieved is woefully incomplete.

The United States, which seems to have a passion for such statistics, estimates that insects still, in a normal year, take a 10 per cent. levy of all human efforts at food production—and a single insect, the cotton boll weevil, is blamed for taking 15 per cent. of the entire cotton output of the southern states. On the other side, it might be argued that yellow fever and malaria—both mosquito-borne diseases—have been largely brought under control, and that the same is true of quite a number of plant pests.

The Civilization of the Ants.

If insects deserve (and secure) attention from their importance, many of them are also of interest in themselves. It is the latter claim which Mr. A. Hyatt Verrill has chiefly stressed in *Strange Insects and Their Stories* (Harrap, 10s. 6d.). "Among them," he writes, "we find nearly every art, industry and phase of human activity duplicated. There are insect masons, carpenters, weavers, divers, aviators, and bridge builders. There are insect soldiers and sailors, insect miners and farmers, insect basket makers and engravers, insects who keep cattle, and insects who have slaves," and, if we put the word "cattle" in quotation marks, it is all true. The reference is to the habit of certain ants of keeping little aphid insects for the sake of their "honey dew," the aphides being all but literally milked and, in some cases, kept in underground "stables" and deliberately fed by the ants during cold weather.

Even more strange are the ant farmers of South America, which make hanging gardens in trees, and cultivate plants which have never been otherwise found. Presumably, they have either been grown by the ants for so many millions of years that distinct species have evolved, or else the original wild plants have disappeared. But of the fact, apparently, there can be no doubt.

How Wasps Ripen Figs.

Then there is "the insect magician who gives us figs"—who alone is capable of bringing Smyrna figs to development and, in the process, commits suicide and forfeits its own prospect of parenthood. The story came to light from the effort of a San Francisco newspaper in the 'eighties to introduce Smyrna fig cuttings into California. The cuttings grew, but instead of big, luscious figs, little wizened buds were the only produce—until a Government expert was sent out to Smyrna to investigate. Here he was struck by the native habit of carefully gathering quantities of inedible wild figs and hanging them on strips in the orchards "to keep away evil spirits." They were so emphatic that this was important that he decided to wait and watch. And here is the answer.

Figs, strictly speaking, are flowers rather than fruit, and require fertilization, when apparently already in the fruit stage, before they will further develop. This is done naturally for the wild caprifigs, by little wasps, which burrow their way in through the "eyes" of the figs and lay their eggs inside. When the young wasps emerge in the orchards they fly unhesitatingly to the cultivated figs, force their way hopefully inside, and then finding the figs unsuitable come out again without laying any eggs and fall helpless and wingless to the ground. The one result of their sacrifice is that the cultivated figs are fertilized. And only by importing fig wasps and wild figs, together, into California, could Californian figs be made to fruit.

Saved by Ladybirds.

From California, too, comes the story of the saving of the orange groves there by the Australian ladybird "Vedalia." This was a case of pitting insect friend against insect foe. The cottony-cushion scale insect, known to have been accidentally introduced from Australia, was decimating the Californian plantations—although reports from Australia showed that, in its native country, it did little or no damage.

An investigator was therefore sent to Australia to discover what it was that kept the cottony-cushion scale in check. He came back with a pretty red and black Vedalia. In six months "they had spread all over southern California and had made such inroads on the scale army that the withered, dying orange trees put forth new leaves and began to bloom once more," and within a year the scale insects were under control.

Mr. Verrill might have told, too, of the prowess of "*Cactoblastis cactorum*," Australia's guest-insect from Brazil, which has already helped Australia to reclaim more than three million acres of agricultural land from the notorious prickly pear. The story, in this case, goes back to 1787, when Captain Phillip, who was in command of the "first fleet," as Australians later came to call it, called at Brazil on his way out.

The Insects were Lost.

There, so it is said, he took on board a supply of cochineal insects, thinking he would like to have a home-made red dye for his red-coats and with the insects he took also a number of cactus plants, prickly pear, on which the insects feed. Unfortunately, the cochineal insects were lost in transit, but the prickly pear—which had merely been incidental—safely arrived.

However, the story of its introduction was known, and so when the original consignment had grown to cover 60,000,000 acres—an area larger than the whole of Britain—it was to Brazil that search parties were sent. "*Cactoblastis*," a name now famous in Australia, has proved the best recruit.

But in a book so packed with odd and varied information it would be unfair to complain of omissions. A more valid criticism is of the manner of appeal—to wonder, and again to wonder—through artisans and mimics, ogres and giants, sawyer beetles and ethereal dragon flies, grave and gay, for the whole length of an evening's reading. The wonder, of course, is there. But it should be taken rather as a series of cocktails, than as a single meal—or else diluted with intervening courses of more solid fare. Apparently Mr. Verrill himself realizes the need. He expresses the hope, at the end of his book, that readers will be encouraged to delve more deeply. He might, with advantage, have met them—quarter way.

THE PRACTICAL APPLICATION OF METEOROLOGY TO AGRICULTURE.*

The subjoined account of the way in which meteorology is applied to agriculture in Europe is of especial interest to New Guinea.

Climatology.

(*a*) General Application of Climatology in the Improvement of Crops.

Weather forecasting is not, as generally thought, the only branch of meteorology which can be useful to agriculturists. There is a second—climatology—of which many agriculturists are unaware, which can, however, render them considerable service. A precise knowledge of climate, that is to say, of the meteorological elements not solely of the air in which we live, but of the air at the surface of the soil and in the soil, can play a capital part in agriculture for the following reasons:—

(1) It will help to increase yields by facilitating the choice of varieties of crops best adapted to the climate; varieties resistant to cold in the east, or drought in the south; early varieties in regions where the heat of July causes "burning" to be feared; varieties of which the critical periods (earing of cereals for example) coincide to the maximum of probability with favorable meteorological phenomena.

(2) It affords a powerful aid in the application of preventive treatment against fungus diseases. Two kinds of conditions are needed for the development of these diseases—those favorable for the fungus and those predisposing the plant to disease. High temperatures, drought, and a high exposure to sunlight are factors propitious to fungi attacking the plant, which is already weakened by a partial withering of its tissues; they form, on the contrary, a powerful obstacle to the development of the propagative organs of the fungus, whose existence they menace. On the other hand, a soft and humid weather favorable to the fungus produces the maximum of turgescence in the tissues of the plant, which is thus better able to resist fungus attack. In order to produce an epidemic it is necessary that these two opposite kinds of conditions must immediately succeed each other, leading, in the first place, to predisposition of the plant to attack, and then to the development of the fungus before the plant can react. Thus at the beginning of the warm weather the plants wither in the day time; now if, in the course of the night, temperature is lower and a mist is produced (an element propitious for the propagation of fungus spores) the fungus attacks the plants, which will not have had time sufficiently to regain their turgescence and the epidemic will break out. On the basis of these data, and from the observation that potato blight always travels from west to east, one can, in

* Translated and summarized by Mr. W. R. Black (Ministry of Agriculture and Fisheries, U.K.) from an article by Mons. J. Sanson (Chief of the Climatological Service of the French National Meteorological Office) in *La Grande Revue Agricole*, March, 1928, and reprinted from *The Journal of the Ministry of Agriculture*, (Great Britain) for October, 1928.

certain conditions of temperature and humidity, and with observation posts judiciously placed, announce the probable advance of this disease in a given region and advocate the necessary preventive treatment.

(3) It will sometimes allow measures to be employed to counteract certain atmospheric phenomena which are particularly dangerous at certain times of the year—use of artificial clouds against spring frosts, formation of societies intended to prevent or insure against hail.

(4) It will assist the rational use of manures. It is known, for example, that lack of water in arable soil impedes nitrification. In very dry regions the extensive use of easily soluble manures may remedy this to a certain extent. In districts with abundant rainfall, where fungus diseases and storms are particularly to be feared, dressings of potassic and phosphatic manures will be increased. These same manures will induce vegetative activity in regions where winter cold and spring frosts lead to the risk of damage to advanced crops. The climatology of the country will be also utilized to fix the dates of spreading manures; for example, the application of potassic manures will be the earlier the drier the climate, that of nitrogenous manures on grass will be carried out as far as possible on dry days at the end of February when rain is imminent. Liming and marling will be done in the dry periods of autumn.

(5) It is indispensable when new crops are tried. Thus, in France, an increase in the area under sugar beet is very desirable. Before this crop is grown in certain departments, their climatology must be known; in particular, whether the distribution of average quantities of rain over the summer months will permit of the advantageous acclimatization of this crop. Sugar is produced as much through the water in the soil as from the carbonic acid in the air. Evaporation from the leaves of beet is considerable, and may reach 350,000 to 500,000 gallons of water per acre, corresponding to a rainfall of about 20 inches, which must be spread over half a year (May to October). It must be ascertained, therefore, that the rainfall can satisfy the need of this crop for water.

(6) Finally, certain meteorological data can be instanced which are of service to agriculturists, e.g., the monthly and annual distribution of rainfall and the amount of maximum falls in the case of the construction of cisterns; the system of winds in the case of the installation of a mill or an airwheel; and extremes of temperature, duration of frosts and their intensity, in the case of heating in glass houses.

(*b*) Study of a Particular Climatological Factor, e.g., Influence of Rain in Agriculture.

Among the climatological phenomena having an important effect on agricultural production, rainfall seems to take first place, and it seems useful by way of example to study, in some detail, the role of rainfall in agriculture.

The amount of rainfall is expressed in inches, a precipitation of 1 inch corresponding to 4.7 gallons of water (i.e., 47 lb.) per square yard, i.e., 22,500 gallons per acre. In France, the average quantity of rain received annually varies according to district, the minimum in the neighbourhood of Paris and the maximum in the neighbourhood of the mountains.

Fertilizing Effects of Rainfall.—The physical and chemical effects of rainfall are well known. Minerals in the soil are rendered soluble, without which they cannot be utilized for the formation of plant tissues. It is, also, through rainfall that fermentation indispensable to plant life takes place in the soil. There is one point to which particular attention must be called, namely, the fertilizing effect of rainfall due to the ammoniacal or nitric nitrogen which it contains in quantities far from negligible. Determinations carried out in France and Belgium have shown that rain contains, on the average, .0002 per cent. of ammoniacal nitrogen and .00007 per cent. of nitric nitrogen. Winter rainfall is, in general, richer in nitrogen than summer rainfall. It is seen that rain brings in an average year some 13 lb. of nitrogen per acre in the region of Paris, and more than 26 lb. in the wetter districts of the country. In Germany and in Italy, the average quantity of nitrogen brought per acre by rainfall has been found to be about 10 lb., and in England about 7 lb., of which three-quarters are ammoniacal nitrogen and one-quarter nitric nitrogen, while, in the United States, it is as large as 20 lb., of which 13 lb. are ammoniacal nitrogen and 7 lb. nitric nitrogen. Rainfall is about ten times richer in nitrates in tropical regions than in temperate climates. The proportion of ammonia is also much higher, which explains the luxuriant vegetation on certain African soils which, from their composition, would be considered as poor. These quantities of nitrogen furnished by rain are much superior to those given in manures, especially in France.

Thus, in some degree, rainfall supplies manure, but the reverse is sometimes the case, and manure can, at least in part, replace water. In order, for example, in the case of wheat, for the plant to manufacture 1 gram of dry matter it has been established that 0.53 pints of water are necessary in unmanured soil and only 0.35 pints in the same soil with average manurial dressings. The transpiration of cereals is, in fact, diminished by the use of manures, and, varying with the dressing of the latter and the nature of the soil, the quantity of water required to produce 33 bushels of wheat per acre, weighing 71 lb. per bushel, has been reduced from 24 inches to 8 inches.

Disadvantages of Excessive Rainfall.—(1) Potash salts are retained by the absorptive power of the soil and suffer only insignificant losses from rainfall. No loss is to be feared so far as concerns soluble phosphatic manures. It is different, however, with nitrates, which are in danger of being lost in drainage water through abundant rainfall in autumn and winter. This point must, however, not be exaggerated. The loss of nitrates in the sub-soil is much less rapid than is often imagined; thus after a rainfall of half an inch, it was found that nitrate only descended a few tenths of an inch in the soil, while the humidity produced by this rain falling on a dry soil had penetrated in one day to 2½ inches. Further in warm weather nitrate may be brought back quite quickly by capillarity from a considerable depth to the surface. Nitrate 10 inches deep in the soil was thus returned to the surface in a fortnight. During this season, capillarity causes the water in the soil to rise to replace that lost in evaporation. This water brings

with it dissolved products deep in the soil, products which thus come to be concentrated in the neighbourhood of the roots of plants. Too deep a burying of nitrates following rain need not be feared when the manures are applied in spring, even if they are ploughed or harrowed in. As, however, nitrates are subject to denitrification in very humid soils, it is advisable, where too heavy rains or a high humidity are to be feared, to replace nitrates by ammoniacal manures. Sulphur, and, above all, lime, are lost through rainfall in larger quantities than any other manurial element. Losses of lime, naturally more important in rainy climate than in a dry district, attain on the average in France 3 to 4 cwt. per acre per annum; in very rainy years they have even reached 4¾ cwt. The practice of liming is, therefore, absolutely necessary, as lime is an indispensable element in the nutrition of plants equally with nitrogen, phosphoric acid, and potash.

(2) Soils which are too wet, i.e., which contain more than 40 per cent. of their weight of water, are, in general, impermeable to air, and thus any gaseous exchange between the soil and the atmosphere is rendered impossible. There results a stoppage of respiration of plant roots, leading to asphyxiation of the plants and a lowering of the temperature of the soil harmful to their growth. The water (which is a bad conductor of heat) remaining in the top layers of the soil is not replaced by air, and, in consequence, these layers, although superficially warm in spring, cannot transmit this warmth to the lower layers, which remain cold. There results, among other things, from this lack of warmth, the impossibility of production of carbonic acid gas in the soil, an indispensable element in the development of the plant, as a complement of carbonic acid gas in the atmosphere. Soils which are too wet lack air and are cold, but it is possible by drainage to aerate and warm them. Experiments have shown that the average temperature of a drained soil can be 6 degrees Centigrade higher than that of an undrained soil.

(3) The substances necessary for the nutrition of plants, concentrated in the neighbourhood of the root hairs, penetrate these latter with the soil water by capillarity and endosmosis and ascend through the plant cells under the impulse of these forces. Their ascension and their absorption are considerably increased by transpiration, which leads to the consumption of an enormous quantity of water compared with that strictly necessary for the tissues. Thus fertilizing elements from the soil reach right to the leaves. If the soil is too dry, transpiration is greater than absorption and plants wither, but, if the soil is saturated, the plants are "gorged" with water and their vegetative apparatus is developed to the detriment of their reproductive apparatus. In this latter case, in effect, the substances in the soil are diluted to too large a degree with liquid, and, since the roots can only absorb a certain volume of water, the plants are deprived of a certain amount of their nutrients, notably phosphates, without which it is impossible for them to live normally. On the other hand they have other nutrients at their disposal in greater quantity, particularly nitrogen brought down in the rainfall. There results an exaggerated growth of the vegetative organs, a diminution of precocity, and a marked tendency to the invasion of fungus parasites. This can be remedied by increasing the potassic and phosphatic dressings.

(4) The year 1927 showed once more that, while abundant summer rain has not always a bad effect on the quantity, it has on the quality of the crop. For wheat, in particular, it has been established that rain at harvest does not lead to the germination of the grain in the sheaf unless accompanied by a sharp fall

in temperature such as is produced at the time of a storm. Such fall of temperature is not an obstacle to germination as one would be tempted to think, but, on the contrary, the determining cause. The damage to the crop is the greater the longer the temperature remains below the normal after rainfall; and inversely the damage is the smaller the more rapidly the thermometer regains the average for the season. In regions where rainfall is abundant during the months of July and August, it is to the interest of farmers to select varieties of wheat which are resistant to this special effect of summer rains.

Correlation Between Rainfall and the Yield of Wheat.

The preceding considerations show the important part played in agriculture by rainfall. It has long been known (it is found for instance in the Bible) that harvests are intimately dependent on rainfall. For the central region of France, in particular, the following rules have been drawn up on the relation between rainfall in the quarter April, May, June, and the yield of the wheat crop:—

(1) If the rainfall during these three months is below average, the yield will be above average so long as the temperature is not more than 1 deg. C. above the average. If the temperature is more than 1 deg. C. above average, the crop is damaged by burning.

(2) If the rainfall during these three months is above average, the yield of wheat is below average.

Analogous conditions have been found in the north of Italy and in Ohio, where a diminution of rain in the spring is accompanied by an increase in the yield of wheat. On the contrary, in the south of France and the southern part of the Italian Peninsula, the effect of rainfall is quite the opposite.

PHASES OF THE MOON, 1938.

RABAUL.

January—		
2-New moon	4.58	a.m.
10-First quarter	12.13	a.m.
16-Full moon	3.53	p.m.
23-Last quarter	0.9	p.m.
31-New moon	11.35	p.m.
15-Perigee	12.0	noon
27-Apogee	4.0	p.m.
February—		
8-First quarter	10.33	a.m.
15-Full moon	3.14	a.m.
22-Last quarter	2.24	p.m.
12-Perigee	4.0	p.m.
24-Apogee	11.0	a.m.
March—		
2-New moon	3.40	p.m.
9-First quarter	6.35	p.m.
16-Full moon	3.15	p.m.
24-Last quarter	11.6	a.m.
11-Perigee	6.0	p.m.
24-Apogee	7.0	p.m.
April—		
1-New moon	4.52	a.m.
8-First quarter	12.10	a.m.
15-Full moon	4.21	a.m.
23-Last quarter	6.14	a.m.
30-New moon	3.28	p.m.
5-Perigee	2.0	p.m.
21-Apogee	3.0	a.m.
May—		
7-First quarter	7.24	a.m.
14-Full moon	6.39	p.m.
22-Last quarter	10.36	p.m.
29-New moon	Midnight.	
2-Perigee	11.0	p.m.
18-Apogee	7.0	p.m.
31-Perigee	3.0	a.m.
June—		
5-First quarter	2.32	p.m.
13-Full moon	9.47	a.m.
21-Last quarter	10.52	a.m.
28-New moon	7.10	a.m.
15-Apogee	4.0	a.m.
28-Perigee	11.0	a.m.
July—		
4-First quarter	11.47	p.m.
13-Full moon	1.5	a.m.
20-Last quarter	10.19	p.m.
27-New moon	1.54	p.m.
12-Apogee	7.0	a.m.
26-Perigee	9.0	a.m.
August—		
3-First quarter	12.0	noon
11-Full moon	3.57	p.m.
19-Last quarter	6.30	a.m.
25-New moon	9.17	p.m.
8-Apogee	1.0	p.m.
24-Perigee	3.0	a.m.
September—		
2-First quarter	3.28	a.m.
10-Full moon	6.8	a.m.
17-Last quarter	1.12	p.m.
24-New moon	6.34	a.m.
5-Apogee	3.0	a.m.
20-Perigee	10.0	p.m.
October—		
1-First quarter	9.45	p.m.
9-Full moon	7.37	p.m.
16-Last quarter	7.24	p.m.
23-New moon	6.42	p.m.
31-First quarter	5.45	p.m.
2-Apogee	9.0	p.m.
16-Perigee	6.0	p.m.
30-Apogee	5.0	p.m.
November—		
8-Full moon	8.23	a.m.
15-Last quarter	2.20	a.m.
22-New moon	10.5	a.m.
30-First quarter	1.59	p.m.
11-Perigee	2.0	p.m.
27-Apogee	1.0	p.m.
December—		
7-Full moon	8.22	p.m.
14-Last quarter	11.17	a.m.
22-New moon	4.7	a.m.
30-First quarter	8.53	a.m.
9-Perigee	11.0	a.m.
28-Apogee	5.0	a.m.

(Apogee.—The point in the moon's orbit farthest from the earth.)
(Perigee.—The point in the moon's orbit nearest the earth.)

CALENDAR FOR 1938.

JANUARY.						
Sunday	..	2	9	16	23	30
Monday	..	3	10	17	24	31
Tuesday	..	4	11	18	25	..
Wednesday	5	12	19	26	..	..
Thursday	..	6	13	20	27	..
Friday	..	7	14	21	28	..
Saturday	1	8	15	22	29	..

FEBRUARY.						
Sunday	..	6	13	20	27	..
Monday	..	7	14	21	28	..
Tuesday	1	8	15	22	..	..
Wednesday	2	9	16	23	..	..
Thursday	3	10	17	24	..	..
Friday	4	11	18	25	..	..
Saturday	5	12	19	26	..	..

MARCH.						
Sunday	..	6	13	20	27	..
Monday	..	7	14	21	28	..
Tuesday	1	8	15	22	29	..
Wednesday	2	9	16	23	30	..
Thursday	3	10	17	24	31	..
Friday	4	11	18	25	..	..
Saturday	5	12	19	26	..	..

APRIL.						
Sunday	..	3	10	17	24	
Monday	..	4	11	18	25	
Tuesday	..	5	12	19	26	
Wednesday	..	6	13	20	27	
Thursday	..	7	14	21	28	
Friday	1	8	15	22	29	
Saturday	2	9	16	23	30	

MAY.						
Sunday	..	1	8	15	22	29	..
Monday	..	2	9	16	23	30	..
Tuesday	..	3	10	17	24	31	..
Wednesday	4	11	18	25	..	..
Thursday	..	5	12	19	26	..	..
Friday	..	6	13	20	27	..	..
Saturday	..	7	14	21	28	..	..

JUNE.						
Sunday	..	5	12	19	26	..
Monday	..	6	13	20	27	..
Tuesday	..	7	14	21	28	..
Wednesday	1	8	15	22	29	..
Thursday	2	9	16	23	30	..
Friday	3	10	17	24	..	..
Saturday	4	11	18	25	..	..

JULY.						
Sunday	..	3	10	17	24	31
Monday	..	4	11	18	25	..
Tuesday	..	5	12	19	26	..
Wednesday	..	6	13	20	27	..
Thursday	..	7	14	21	28	..
Friday	1	8	15	22	29	..
Saturday	2	9	16	23	30	..

AUGUST.						
Sunday	..	7	14	21	28	
Monday	1	8	15	22	29	
Tuesday	2	9	16	23	30	
Wednesday	3	10	17	24	31	
Thursday	4	11	18	25	..	
Friday	5	12	19	26	..	
Saturday	6	13	20	27	..	

SEPTEMBER.						
Sunday	..	4	11	18	25	..
Monday	..	5	12	19	26	..
Tuesday	..	6	13	20	27	..
Wednesday	7	14	21	28	..	..
Thursday	1	8	15	22	29	..
Friday	2	9	16	23	30	..
Saturday	3	10	17	24	..	..

OCTOBER.						
Sunday	..	2	9	16	23	30
Monday	..	3	10	17	24	31
Tuesday	..	4	11	18	25	..
Wednesday	..	5	12	19	26	..
Thursday	..	6	13	20	27	..
Friday	..	7	14	21	28	..
Saturday	1	8	15	22	29	..

NOVEMBER.						
Sunday	..	6	13	20	27	..
Monday	..	7	14	21	28	..
Tuesday	1	8	15	22	29	..
Wednesday	2	9	16	23	30	..
Thursday	3	10	17	24	..	..
Friday	4	11	18	25	..	..
Saturday	5	12	19	26	..	..

DECEMBER.						
Sunday	..	4	11	18	25	
Monday	..	5	12	19	26	
Tuesday	..	6	13	20	27	
Wednesday	..	7	14	21	28	
Thursday	1	8	15	22	29	
Friday	2	9	16	23	30	
Saturday	3	10	17	24	31	

Extract From "Summary Report, Resolutions, and Reports of Committees" issued in connexion with the Fourth British Empire Forestry Conference—South Africa, 1935.

Tropical Forestry in Relation to Agriculture.

The importance of close co-operation between forestry, agricultural and other services, in promoting the general welfare of a country, was stressed, particularly in regard to the control of shifting cultivation with its attendant destruction of forests and all the evils that it entails. Such co-operation is already effective or is developing in some countries, e.g., the Gold Coast, Mauritius and Nyasaland.

In Nyasaland, excellent progress has been made by putting into effect the village forest scheme (explained in a paper) which puts reserved forest areas under control of the village headmen and gives the people a direct interest in them. All co-operative schemes must go hand in hand with education and demonstration in modified agricultural and pastoral methods to prevent loss of soil and to maintain the fertility of the land. Co-operation between forest, agricultural and other officers is necessary in the first instance in assigning areas for forestry and agricultural purposes respectively, so that environmental conditions required for specific crops such as cocoa, rubber, clover, &c., may be safeguarded. Each service has its special knowledge to contribute to the end that the best and most enduring results may be secured. Without the help given by forestry, the agricultural possibilities of a land decrease and may ultimately disappear.

Forestry also enters very definitely into the solution of the tsetse problem. In high forest, though tsetse may be present, animals are immune or tolerant; where forests have been destroyed there are found peak regions of fatal incidence of trypanosomiasis. In the control of this pest, co-operation by many sciences including forestry is essential.

Shifting cultivation, though usually a bad master, can be made into a good servant as exemplified in the "taungya" system which, when properly applied in the formation and regeneration of forests, serves the ends of both forestry and agriculture. Stress was laid on the fact that foresters should always be ready to step out of their own province in order to help agriculture, and to combat any prejudice that might exist to the effect that forestry has no application in agricultural or pastoral pursuits. The appointment of experts trained in the science of vegetation, to act as liaison officers between forestry and agriculture, was considered to be well worth consideration.

It was pointed out that timber exploitation in the tropics is generally somewhat speculative and that a selective technique is usually most appropriate in the exploitation of rain forests in the moist tropics both on silvicultural and on economic grounds. Highly mechanized methods of exploitation entail high capital costs and highly paid labour for operation and maintenance of mechanical transport. The view was expressed that where labour is cheap and efficient, it is not economical to go in for elaborate mechanization and that simple extraction methods which rely largely on hand labour for the operation of tramways, slides, &c., will prove more satisfactory and economical.

LEGISLATION.

THE COMMONWEALTH OF AUSTRALIA.

PAPUA AND NEW GUINEA BOUNTIES.

No. 35 of 1937.

AN ACT TO PROVIDE FOR THE PAYMENT OF BOUNTIES ON CERTAIN GOODS THE PRODUCE OR MANUFACTURE OF THE TERRITORY OF PAPUA AND ON CERTAIN GOODS THE PRODUCE OR MANUFACTURE OF THE TERRITORY OF NEW GUINEA.

[Assented to 16th September, 1937.]

BE it enacted by the King's Most Excellent Majesty, the Senate, and the House of Representatives of the Commonwealth of Australia, for the purpose of appropriating the grant originated in the House of Representatives as follows:—

1. This Act may be cited as the *Papua and New Guinea Bounties Act* 1937.

2. This Act shall commence on the first day of January, One thousand nine hundred and thirty-eight.

3. There shall be payable out of the Consolidated Revenue Fund, which is hereby appropriated accordingly, the bounties specified in this Act.

4.—(1.) The bounties under this Act shall be payable on the goods, the produce or manufacture of the Territory of Papua or of the Territory of New Guinea, which are specified in the Schedule to this Act, on importation into the Commonwealth for home consumption therein, provided that—

(*a*) the goods are imported either within the period prescribed in the third column of that Schedule or within the period prescribed in the Schedule to the *Papua and New Guinea Bounties Act* 1926-1936; and

(*b*) the goods have been imported direct from the Territory in which they were produced or manufactured.

(2.) The bounty payable in respect of any goods specified in the first column of the Schedule to this Act shall be payable at the rate specified in the second column of that Schedule opposite to the name or description of those goods.

5. Bounty under this Act shall not be payable—

(*a*) to any person other than the exporter or his authorized agent;

(*b*) in respect of any goods which are not of good and merchantable quality; or

(*c*) in respect of any goods upon which bounty has been paid under the *Papua and New Guinea Bounties Act* 1926-1936.

6. Every claimant for bounty under this Act in respect of any goods shall produce—

(*a*) a certificate signed by the principal officer of Customs at the port of shipment in the country of export that the goods are the produce or manufacture of the Territory of Papua or of the Territory of New Guinea, as the case may be; or

(*b*) such other evidence of the origin of the goods as the Minister requires.

7. The Minister may, in relation to any claim for bounty under this Act, require such information as to the correctness of any certificate produced under the last preceding section, or otherwise, as he deems necessary.

8. No person shall—

(*a*) obtain payment of any bounty under this Act which is not payable;

(*b*) obtain payment of any bounty under this Act by means of any false or misleading statement; or

(*c*) present to any officer or other person doing any duty in relation to this Act or the regulations any document, or make to any such officer or person, any statement, which is false or misleading in any particular.

Penalty: One hundred pounds or imprisonment for twelve months.

9.—(1.) A return shall be prepared not later than the thirty-first day of August of each year, and shall be laid before both Houses of the Parliament within thirty days after its preparation, if the Parliament is then sitting and, if not, then within thirty days after the next meeting thereof.

(2.) The return shall set forth in respect of the preceding financial year and in respect of each class of goods produced or manufactured—

(*a*) the number of persons, firms or companies to whom bounty under this Act has been paid;

(*b*) the total quantity on which bounty has been paid; and

(*c*) the total amount of bounty paid.

10. The Governor-General may make regulations, not inconsistent with this Act, prescribing all matters which by this Act are required or permitted to be prescribed, or which are necessary or convenient to be prescribed, for carrying out or giving effect to this Act, and in particular for prescribing penalties not exceeding fifty pounds for any breach of the regulations.

THE SCHEDULE.

First Column. Goods.	Second Column. Rate of Bounty.	Third Column. Period of Bounty.
1. Cocoa Beans, raw, whole or broken ..	1½d. per lb.	Ten years from and including 1st January, 1938
2. Cocoa Shells, raw	1½d. per lb.	Ten years from and including 1st January, 1938
3. Fibres, viz. :—		
(*a*) Manila and Sisal Hemp and other hard fibres known commercially as hemp, as determined by the Minister	£6 per ton	Ten years from and including 1st January, 1938
(*b*) Coir	£3 per ton	Ten years from and including 1st January, 1938
4. Sago, not packed for household use ..	1d. per lb.	Ten years from and including 1st January, 1938
5. Beans, Vanilla	2s. per lb.	Ten years from and including 1st January, 1938
6. Bamboos and Rattans, unmanufactured (including clouded)	£4 per ton	Ten years from and including 1st January, 1938
7. Spices, Unground, viz. :—Nutmegs, Mace, Pepper, Cloves and Ginger	1½d. per lb.	Ten years from and including 1st January, 1938
8. Other Spices, unground	½d. per lb.	Ten years from and including 1st January, 1938
9. Kapok	2d. per lb.	Ten years from and including 1st January, 1938